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MYSORE, INDIA

POSTER SESSIONS' ABSTRACTS

FOOD TECHNOLOGY UPDATE

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PREFACE

The response to the Third International Food Convention (IFCON-93) organised by the Association of Food Scientists and Technologists (India) and Central Food Technological Research Institute at Mysore from 7th to 11th September 1993 has been overwhelming as reflected by technical contributions, from over 140 invited speakers and 450 poster paper presentations scheduled for the 5 day technical event. Symposia papers received by the secretariat have been edited, wherever necessary, and abstracts of the same were prepared for inclusion in the Souvenir. The abstracts of the poster session papers have been compiled and published in this publication. Inspite of the last date stipulated for contributions in poster session, a sizeable number of papers were received rather late and this has made the task of Poster Programme Committee all the more formidable. Inspite of this, the Committee headed by Dr S.C.Basappa was able to organise the papers into a coherent presentation programme and make available the material after due editing, wherever necessary. The abstracts have been classified into eleven broad areas in Food Science and Technology and included in this publication. We are grateful to Members of the Committee for their services in the task. Our special thanks are due to Dr S.C.Basappa, Chairman and Dr M.C.Varadaraj, Convener of the Poster Session Committee who were instrumental in coordinating this activity and its completion. We are thankful to M/s Kwality Computers, Mysore, for computer typesetting and M/s Skanda Offset Printers, Mysore, for printing this publication in time. It is hoped that the publication will serve as an useful and reliable reference source of technical information to all those interested in Food Science and Technology.

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President, AFST(I)

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TIME SCHEDULE FOR POSTER PRESENTATION

Session, Date & Time	Subject Categories and Abstract Numbers										
	ANM	APT	BTM	DRS	FCN	FEG	FVP	GST	MBT	OFT	MIS
Session I, 7.9.93 1500 - 1630 Hrs	01 - 02	01 - 07	01 - 12	01 - 04	01 - 10	01 - 03	01 - 11	01 - 03	01 - 02	01 - 02	
Session II, 8.9.93 0930 - 1100 Hrs	03 - 05	08 - 13	13 - 23	05 - 07	11 - 19	04 - 05	12 - 22	04 - 05	03 - 04	03 - 04	01 - 02
Session III, 9.9.93 0900 - 1030 Hrs	06 - 08	14 - 19	24 - 35	08 - 10	20 - 28	06 - 07	23 - 33	06 - 07	05 - 06	05 - 06	03 - 04
Session IV, 9.9.93 1100 - 1230 Hrs.		20 - 27	36 - 47	11 - 14	29 - 38	08 - 11	34 - 45	08 - 11	07 - 09	07 - 08	05
Session V, 9.9.93 1500 - 1630 Hrs.		28 - 34	48 - 59	15 - 18	39 - 47	12 - 15	46 - 57	12 - 14	10 - 12	09 - 11	
Session VI, 10.9.93 0900 - 1030 Hrs.		35 - 41	60 - 71	19 - 22	48 - 57	16 - 19	58 - 68	15 - 18	13 - 15	12 - 14	
Session VII, 10.9.93 1100 - 1230 Hrs.		42 - 48	72 - 83	23 - 26	58 - 67	20 - 23	69 - 79	19 - 21	16 - 17	15 - 16	
Session VIII, 10.9.93 1500 - 1630 Hrs.		49 - 55	84 - 95	27 - 29	68 - 77	24 - 27	80 - 90	22 - 25	18 - 20	17 - 18	

Venue : Sessions I & II : Kalamandir
Sessions III to VIII : Quadrangles of Assembly Hall, CFTRI.

ANALYTICAL METHODS

ANM-1 STAINING TECHNIQUE TO IDENTIFY ADULTERATION IN *BASMATI* RICE

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Pleasing aroma, tenderness and extra elongation of cooked grains of *basmati* rice have conferred it a status in the international market. It fetches a foreign exchange to the tune of Rs. 600 crores annually. Progress in the trade is, however, facing new challenges due to lack of definite *basmati* standards and adulteration resulting in quality deterioration. Breeders and field managers are devising methods of avoiding varietal and field mixing, but deliberate adulteration for economic gain is increasing unabated.

A simple technique to detect adulteration of *basmati* with non- *basmati* rice was investigated. The technique involves dyeing of suspected rice with a series of stains and counter stains followed by intermittant washings using aqueous solutions. Differential colour enables to estimate the proportion of non- *basmati* rice used for adulteration.

ANM-2 USE OF NEAR INFRARED REFLECTANCE SPECTROSCOPY AS A TOOL FOR FOOD ANALYSIS

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Near infrared reflectance spectroscopy has been used in laboratories for more than ten years. In food industry, use of Near Infrared Reflectance (NIR) Analysis has expanded from analysis of raw materials like grains, oilseeds, feedstuffs to rapid on-line process control and monitoring for dry milling of wheat, corn, oats and rice. Quality monitoring parameters during processing for the analyte protein, moisture, oil/fat, starch, fibre, ash etc., using NIR instruments designed to quickly and accurately measure in percent these constituent concentrations have been recently developed and are available as continuous spectral scanning instrument from NIR systems or as multi-wave length filter instruments made by Dickey-john Pacific Scientific and Technicon. These instruments and their use in food research laboratory are briefly discussed. Instrumental considerations, modern hardware are briefly discussed. Instrumental considerations, modern hardware features, reliability of measurement, sample preparation, computation of analyte concentrations are some of the aspects dealt with. Methods of obtaining NIR analysis values and spectroscopic determinations of percent proteins and other constituents using multiple regression, linear equations and statistical procedures are discussed. Typical software developed at Central Food Technological Research Institute, Mysore for obtaining calibration coefficients for constituent estimations for food products like energy food, *jamoon* mix, sweet *boondi* and wheat products are presented.

ANM-3 PERFORMANCE OF NINE MAJOR METHODS AND DEVELOPMENT OF IMPROVED TECHNIQUE FOR PROTEINASE ESTIMATION BY CASEINOLYTIC DIGESTION

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Data on comparative efficacies of nine major caseinolytic digestion methods for proteinase assay indicate significantly different responses as the estimates ranged between 61667-348116 units/g enzyme powder, even at constant enzyme/substrate ratio and equal reaction time. The method of Naganishi *et al*, which gave highest titres, was selected for further improvements and no change was seen when the standing time of the reaction mixture was varied (15-60 min at 30°C), while the estimates improved by 10 percent when standing temperature was at 60°C. TCA mixture liberated more tyrosine from the digestion products as compared to different concentrations of TCA alone. The methods used for estimation of the digestion products were found to have greater impact on the estimations, the method of Lowry *et al* being most efficient. Pure tyrosine also showed highest value by Lowry *et al* method, thereby eliminating any role of non-tyrosine compounds in higher estimations. Improved methodology formulated consists of reacting 0.5 ml of suitably diluted enzyme with 3 ml of 0.6 percent casein in 0.01 M buffer at optimum temperature and pH of the enzyme, for 10 min, terminating the reaction with TCA mixture, releasing of tyrosine by standing at assay temperature for 15 min and subjecting the filtrate for tyrosine estimation by Lowry's method. As compared to Kunitz's method, this method gave 2.2 time more enzyme activity.

ANM-4 GAS CHROMATOGRAPHIC DETECTION OF *ESCHERICHIA. COLI* IN FOODS

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Absence of *Escherichia. coli*, an indicator bacterium of intestinal origin is used as an index of safe food. Recently, a large number of rapid methods of detection of *E. coli* in food and clinical samples have been described. Gas chromatographic method is one such rapid method that can detect *E. coli*. It is based on the GC detection of metabolically produced ethanol in a defined medium in which suspected *E. coli* containing sample is grown at 44°C. Standard curve for various concentrations of ethanol varying from 50 to 900 ppm was prepared. Milk samples with *E. coli* were grown in the defined medium for 5 h and ethanol in the spent culture was analysed by GC. Metabolically produced ethanol at 100 ppm concentration can easily be detected by GC. This technique could help as a rapid method for detection of *E. coli* in milk. Another advantage of the method is that only microlitre quantity of sample need be injected to GC and the technique could be automated. Looking at the sensitivity of the equipment and rapidity of the procedure, the gas chromatography appears to have a good potential in food microbiology.

ANM-5 RELATIONSHIP BETWEEN CONCENTRATION AND CIELab PARAMETERS FOR COMMERCIAL STANDARD COLOURS

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Colourants are used in many food preparations, especially in beverages and sweets. It is then necessary to study the effect of concentration on CIELab parameters and sensory ranking. An attempt was made to study the effect of variations in concentration (as geometric series with different common ratios) for commercially available colours such as carmoisine, ponceau, sunset yellow, brilliant blue, indigo blue and tartrazine on CIELab attributes of L*, a*, b*, and other derived parameters. The relationship between concentration and CIELab parameters and segregation of important parameters was explored using principal components analysis. It was interesting to note that, for different colours, the effect of concentration variations was reflected in different sets of CIELab parameters.

ANM-6 A SIMPLE AND ACCURATE GC/MS METHOD FOR THE QUANTITATIVE ANALYSIS OF DIACETYL IN BEER AND WINE

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Diacetyl is a secondary product of microbial metabolism widely found in fermented food products such as wine, beer and cheese. It is also readily formed during Maillard browning reaction. Threshold for diacetyl in food systems varies from ppb to ppm. Its presence in food can be desirable or undesirable, depending on the product and the concentration present. The quantitative analysis of diacetyl is made difficult by its high volatility, low concentration, and the interference of other food components such as acetoin, ethanol, SO_2 and other diketones. The new GC/MS method described overcomes these difficulties. The method is based on the reaction of diacetyl and 4,5-dichloro-1,2-diaminobenzene (DCDB) to form 6,7-dichloro-2,3- dimethylquinoxaline (DCDMQ), a stable high retention index compound. The reaction was carried out directly in the wine sample at 40°C for 90 min. The derivatized compound was extracted in benzene and quantified by GC\MS. Advantages of the described method include the elimination of the extraction step and the resulting reduction in loss of diacetyl, the simple extraction of DCDMQ and the excellent GC/MS characteristics of the derivative. As demonstrated by the low concentration of diacetyl detected (< 0.01 ppm), the high linearity of the standard curves (> 0.990) and the high recovery of diacetyl in spiked samples (> 90%), the method was sensitive, precise and accurate.

ANM-7 PROCESSING OF WOOD CHARCOAL TO OBTAIN EFFECTIVE PESTICIDE ADSORBENT

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Occurrence of harmful pesticide residues in water is a global phenomenon. Most of the water treatment methods applied for the removal of pathogenic bacteria do not remove the pesticide residues present in water. It is demonstrated that a specific variety of wood charcoal is a good adsorbent for the pesticide residues. This charcoal of specific grade for the removal of pesticide residues from water is obtained as a by-product in the kiln designed for the heat activation of acid activated clay which is used as non-toxic grain protectant. Among the different wood pyrolised in the kiln, it was found that Rain tree and Dindalu wood which were processed at 800°C gave charcoal which was reported to adsorb maximum pesticide residue. For the process of removal of pesticide residues, this specific grade charcoal has been pulverised to get particular particle size. 92% of Lindane upto 200 L water and 91% removal of Sevin upto 50 L water at a flow rate of 2.5 ml/min in column experiment have been reported. 50% of DDT removal by 500 mg wood charcoal per litre in 2.5 h contact time has been reported in reactor experiment. The charcoal used for pesticide adsorption can be recycled twice by washing with organic solvent and heat activating each time.

ANM-8 EVALUATION OF PROPYLENE GLYCOL AS A FOOD GRADE SOLVENT

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Propylene glycol (PG) is one of the most widely used solvents in food industry as a Carrier Solvent for food flavourings, colours, vitamins as well as a food additive in the form of humectant. Food grade PG has to be free from its closely related toxic solvent namely, ethylene glycol (EG). Reliable methods are not available for the detection of EG in PG. Thin-layer chromatographic method on silica gel-G, chloroform-acetone- ammonium hydroxide (5N) in 1:8:1 proportion as developing solvent and dichromate-sulphuric acid as spray reagent for separation and detection of EG in PG was developed. Quantitation of separated EG in PG was then, carried out by colorimetric method using sodium meta periodate, sodium arsenite and chromotropic acid. Gas-liquid chromatographic method using Carbowax as stationary phase and FID detector, has been standardised for detection and determination of EG in PG after a preliminary separation of EG by TLC.

ANIMAL PRODUCTS TECHNOLOGY

APT-1 EFFECT OF PHOSPHATE ON THE QUALITY OF MUTTON *KABABS*

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Kababs offer great scope for developing as a popular meat product for fast food industry in India and other countries. However, the technology of *kababs* is traditional and, more or less, limited. In the present study, the effect of tetrasodium pyrophosphate (TSPP), at maximum permissible limit (0.5 percent), on the quality of *kababs* from hot chilled and frozen mutton was investigated. Minced meat was used to prepare a hand mix (batter) and *kababs* were moulded on skewers and charbroiled. Results indicated a significant improvement in the quality of phosphate treated *kababs* from all-the three handling conditions of mutton by way of better stability and higher pH of raw batter, higher cooking yield and increased retention of moisture in the cooked product. For these parameters, the magnitude of improvement over control averaged 19.98 percent, 0.41 units, 6.46 percent and 1.24 percent, respectively. Sensory evaluation on an 8-point descriptive scale revealed that, irrespective of meat handling conditions, TSPP added *kababs* obtained significantly higher scores for all the attributes studied, viz., appearance, flavour, juiciness, texture, mouth coating and overall palatability. It was concluded that TSPP (at 0.5 percent level) could be used in commercial preparations to improve the quality of mutton *kababs*.

APT-2 STUDIES ON MICROBIAL PROFILES OF DRESSED POULTRY PROCESSED IN SEMI-MECHANISED SMALL SCALE POULTRY PROCESSING PLANTS

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Microbiological assessment was carried out on dressed broiler poultry from a semi-mechanical small scale poultry processing unit of capacity of 250-300 birds/day. Hygienic and sanitary precautions were followed during processing. The skin of the live birds showed low levels of micro-organisms indicating the healthy conditions of the birds. Scald water and evisceration process were the major sources of contamination. However, final wash reduced the microbial levels of dressed birds. Microbial counts (log_{10} cfu/g) on dressed bird after final wash were total plate counts 5.3-5.4, coliforms 0.5-1.2; *Staphylococcus* 2.9-3.1 and psychrotrophs 1.7-2.3. The dressed birds were free from *Salmonella*. Chilling (in slush ice) effectively reduced the microbial counts of pathogens on dressed birds. The shelf-life was found to be 7 days at $4\pm1^{\circ}C$ in dressed birds and

10 h at ambient temperature (28-30°C). Analysis of dressed birds from the local market revealed high levels of microorganisms, including *Staphylococcus* and *Salmonella*. The study revealed that processing of poultry in small scale processing plant under hygienic conditions improved the wholesomeness, safety and shelf-life of dressed poultry.

APT-3 PHYSICO-CHEMICAL, MICROBIAL AND SENSORY CHARACTE-RISTICS OF HARD COOKED EGGS PRESERVED IN CITRIC ACID SOLUTIONS

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Studies were conducted to investigate the effect of preserving hard cooked eggs in 0.5, 0.75 and 1.0 percent citric acid solutions. Freshly laid eggs were held for 48 h at 22°C and hard cooked by severe boiling method. The peeled eggs were randomly divided into three groups and placed in above solutions (1:1.5 wt : wt egg to solution) and stored at 5°C. Samples were analysed for physico-chemical changes, microbial and sensory profiles at 0, 1, 7, 14, 20, 30 and 40 days of storage. The pH of solution decreased with increasing level of citric acid and it got equilibrated with the egg by 7th day of storage. Egg solids were lost to the solution during equilibrating and the greatest leaching occurred during the first 24 h of storage, whereas shrinkage in egg weight was greater at 14th day of storage. Changes in original odour and flavour of hard cooked eggs due to preservation in citric acid were demonstrated by sensory attributes. Though egg odour scores declined at the end of storage, no off-odour or off-flavour was detected in any treatment. Further, the counts of different organisms did not increase appreciably in egg samples during storage and even the minimum level of citric acid (0.5 percent) was found to be equally effective in controlling the microbial growth during storage.

APT-4 EFFECT OF STORAGE ON PEELING CHARACTERISTICS AND QUALITY OF HARD COOKED SHELL EGGS

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Studies were conducted to examine the possibility whether storage (5°C) of hard cooked shell eggs would improve the peeling quality. Freshly laid eggs were held for 24 h at ambient temperature and then hard cooked. The eggs were evaluated for peeling characteristics and quality at 0, 3, 5, 7, 10, 14, 18 and 21 days of storage at 5°C. No significant improvement in peelability was observed due to storage. Similar trend was noted for peeled surface appearance and yield of peeled eggs. Peeling time also did not vary significantly among storage periods. pH and moisture content of cooked albumen remained almost same during storage. Microbiological studies of egg contents indicated almost similar total plate counts in stored as well as in fresh hard cooked eggs, but staphylococcal counts increased significantly during storage. Coliforms were absent initially, but

appeared after 14 days of storage. Yeast and mold counts did not vary during storage. Yolk flavour scores decreased significantly from 5th day onwards, but unacceptable yolk flavour and egg odour were noticed at 18th day of storage. Results indicate that storage of hard cooked shell eggs is not a remedy for the peeling problem. In addition, it results in a rapid loss of flavour.

APT-5 QUALITY OF CARCASSES FROM BROILER CHICKENS OF DIFFERENT LIVE WEIGHT GROUPS

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Forty eight White Leg Horn broiler chickens procured from local poultry farm were divided into four groups of different live weight range, viz., (1) 2000-2350 g, mean = 2148.9 g (n = 18), (2) 1900-1980 g, mean = 1950 g (n = 7), (3) 1790-1890 g, mean = 1841.8 g (n = 11) and (4) 1550-1700 g, mean = 1648.3 g (n = 12). Data on yield of carcass, wings, breast, legs, back (and their meat/bone ratios), neck, giblet, head, shanks and offals were collected. The work was undertaken to find out the optimum live weight of broiler chicken for slaughter. Carcass (including neck and giblet, a salable product) yield expressed as percent live weight was about 74 percent in the first three high weight groups. The lowest weight group had a very low carcass yield (68.3 percent). The yields of cut-up parts, meat and bone were significantly higher with heavier birds. Meat-to-bone ratios of different cut-up parts generally favour slaughter at higher live weight above 1.8 kg. Giblets, head and shanks and offal yields were marginally different for different live weight groups.

APT-6 OPTIMISATION OF THE FERMENTATION PROCESS FOR ENSILING THE TROPICAL FRESH WATER FISH VISCERA

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Viscera from fresh water fish constitutes 5-13 percent of body weight and consists of about 67 percent water, 9.6 percent protein, 14 percent ether extract and 3.3 percent minerals. Process of ensiling the offals using fermentation with different levels of molasses (5.0, 7.5, 10.0 and 12.5 percent) and salt (0, 2 and 4 percent) was studied in order to optimise the conditions of fermentation process for preservation of nutrients. Titrable acidity, pH (production of acid) and rise in volume of fermentation mixture (due to production of gas) were measured periodically. The results revealed that the offals when homogenised with 5 percent molasses, the off-odour was noticed within 24 h indicating the inadequacy of molasses for effective fermentation. With 7.5 percent molasses, production of acid was very slow and at 10 percent level, high quantity of acid was produced (lowest pH) within 3-4 days. Molasses at 12.5 percent level did not show any additional advantage

suggesting that the minimum of 10 percent molasses is required for fermentation process. Degree of swelling of the fermentation mixture due to production of gas was found to be lower with higher levels of molasses. Inclusion of salt was effective in suppressing swelling, 4 percent of salt being more effective.

APT-7 EFFECT OF DIFFERENT TYPES OF SALT ON FERMENTATION PROCESS IN FISH SAUCE PREPARATION

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A process for the preparation of fermented fish sauce using three different types of salt viz., white crystalline, black crystalline and table salt at 3.5:1 of fish to salt ratio is described. Chemical analysis included volatile bases (as nitrogen), total nitrogen, alpha amino nitrogen, volatile acids, salt content, pH and free amino acid as tyrosine. Total bacterial counts including halophilic bacterial counts were estimated during different stages of fermentation. At the end of nine months, filtered fish-salt mixture was evaluated for organoleptic quality. There was no significant difference in the rate of fermentation and the quality of fish sauce prepared by using the three types of salts.

APT-8 ACCEPTABILITY OF HEAT TREATED TURKEY MEAT FOR PRODUCTION OF MEAT *PATTIES*

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Hand deboned turkey meat, heated to 65°C, a temperature established for destruction of pathogens in different food products was used for production of meat *patties* using a standard formulation developed with and without 10 percent milk powder; incorporating unheated and heated meat (at levels of 0, 25, 50, 100 percent heated meat). The finished products were evaluated for their organoleptic and textural properties. The study revealed that meat *patties* prepared were unsatisfactory when it contained heat treated meat beyond 25 percent. Loss of juiciness, firmness and overall acceptability were some of the constraints in the process besides increased reheating loss. However, samples prepared using pre-heated meat with milk powder were superior in sensory score.

APT-9 UTILITY OF CALCIUM CHLORIDE INJECTION AND SORBATE TREATMENT ON THE ACCEPTABILITY OF MUTTON CUTS

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Ovine carcass cuts prepared immediately 30 min after exsanguination were injected with 0.3 M calcium chloride upto 10 percent of their weight, followed by dipping for one minute in 5 percent (w/w) solution of potassium sorbate and then aged for 1, 5, and 10 days at $4\pm1^{\circ}C$ to assess the effect of treatment on shear force, sensory panel rating, microbial load and shelf-life. Cuts made from one half of the carcass were used for treatment, while the other half acted as control. The study revealed a significant decrease ($p<0.05$) in shear force value of each injected cut, improvement in sensory rating and superior microbiological status when compared to control ones. Spoilage changes appeared in control samples at 7 days and treated samples at the end of 12 days.

APT-10 STUDIES ON FUNCTIONAL CHARACTERISTICS OF PRE-RIGOR MEAT

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Pre-rigor or hot meat is recognised as an ideal meat for product development due to its convenience in handling, saving of labour and energy. In the present work, functional properties were studied in the pre-rigor and post-rigor meat from male sheep. The carcass weight groups selected for the study were: (1) 4-8 kg (2) 8-12 kg (3) 12-16 kg. Analyses were carried out in each group using different muscles, viz., biceps femoris (BF), semi- membranosus (SM) and semi-tendinosus (ST) to study the variations in pH, water holding capacity, moisture, total nitrogen and salt soluble nitrogen. The results indicated that pre-rigor meat had superior functional properties than post-rigor meat. Carcass weights ranging from 8-12 kg showed better functional properties suitable for meat emulsions than the other two groups. Meat emulsion product (meat loaf) prepared from pre-rigor meat was rated better than that of post-rigor meat from the point of texture, juiciness, colour, taste, aroma and flavour.

APT-11 INCORPORATION OF RAW AND HYDROLYSED FASCIA IN MUTTON *PATTIES*

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A study was envisaged to work out suitable levels of incorporation of raw and hydrolysed fascia in mutton *patties* without any loss in quality and acceptability. Fascia from healthy Muzaffarnagri sheep carcasses was defatted and dried. Powdered fascia was hydrolysed with 0.1 percent pepsin. Mutton *patties* were prepared by incorporating raw and hydrolysed fascia at 10 percent and 20 percent levels replacing lean and were analysed for their proximate composition quality chracteristics like emulsion stability, pH, cooking loss, shear force value and nutritional characteristics like collagen, free amino acids, non-protein nitrogen, available lysine content and protein efficiency ratio. The quality characteristics indicated that stable emulsion could be prepared by incorporating raw fascia upto 20 percent level. There was a significant decrease in emulsion stability when fascia was incorporated in hydrolysed form at 10 and 20 percent levels. Cooking loss was not affected in presence of raw fascia, whereas incorporation of hydrolysed fascia resulted in significant increase in cooking loss. There was a significant increase in free amino acids, non- protein nitrogen and available lysine content of *patties* with raw and hydrolysed fascia at 20 percent level. Microscopic examination showed that emulsions with raw fascia upto 20 percent level of incorporated were stable. Bundles of collagen fibres were seen distributed throughout the field. *Patties* incorporated with hydrolysed fascia showed fat globules of similar size of emulsion with raw fascia. SDS-PAGE of the raw and hydrolysed fascia indicated that the bands of high molecular weight compounds occurring in the native collagen disappeared. Subsequent appearance of bands of low molecular weight components in hydrolysed fascia indicated proteolysis of collagen.

APT-12 STORAGE STABILITY OF MUTTON *PATTIES* INCORPORATED WITH RAW AND HYDROLYSED FASCIA

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A study was envisaged to compare the acceptability and shelf-life of mutton *patties* incorporated with raw and hydrolysed fascia at 20 percent level and stored under refrigeration ($4\pm1^{\circ}C$). It was observed that the pH of all the three groups of *patties* viz., control, with raw fascia at 20 percent level and with hydrolysed fascia at 20 percent level, did not change during storage. The TBA values increased significantly in all the three groups as the storage progressed from 0 to 15 days. However, *patties* incorporated with hydrolysed fascia showed lower TBA values. The standard plate counts showed marginal and non-significant increase in all the three groups of *patties* during storage.

The sensory evaluation scores for general appearance, flavour, texture, mouth coating, juiciness and overall acceptability of mutton *patties* with raw and hydrolysed fascia upto 20 percent level ranged between good and very good. No significant difference in the sensory evaluation scores of three groups of *patties* for the above metioned quality parameters were observed. It was concluded that mutton *patties* of all the three groups could be safely preserved at refrigeration temperature for 15 days.

APT-13 EFFECT OF PROCESSING AND STORAGE ON THE DEVELOPMENT OF OXYSTEROLS IN PORK AND RABBIT MEAT

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A study was initiated to see the effect of processing and storage on the development of oxysterols in pork and rabbit meat. Minced pork and rabbit meat were subjected to broiling and pressure cooking. The raw (control), broiled and pressure cooked samples were packed in polyethylene bags of 150 gauge and stored under refrigerated (4°C) and frozen (-10°C) conditions for 6 and 90 days, respectively. Lipid was extracted and oxysterols were estimated at regular intervals of 0, 3, 6 days for refrigerated, and 0, 30, 60, 90 days for frozen samples. Significant cooking method effect and storage effect were observed on percent distribution of cholesterol oxides in both the meats. However, cholesterol beta-epoxide was not affected by cooking in rabbit meat. In a pork, broiling recorded significantly higher values compared to pressure cooking for all the fractions, except unidentified one which showed decrease. In rabbit meat, there was a significant increase in all the fractions of cholesterol oxides on broiling, except cholesterol beta-epoxide. All the cholesterol oxide fractions percentage increased significantly during refrigerated as well as frozen storage. The unidentified fraction of pork and rabbit meat decreased significantly during both the storages. It was pointed out that cooked stored meat might be consumed with reservation.

APT-14 EFFECT OF PROCESSING AND STORAGE ON DEVELOPMENT OF CHOLESTEROL OXIDATION PRODUCTS IN MUTTON AND BUFFALO MEAT

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The effect of processing and storage on the development of cholesterol oxides in mutton and buffalo meat was studied. Minced mutton and buffalo meat were subjected to broiling and pressure cooking. The raw (control), broiled and pressure cooked samples were packed in polyethylene bags of 150 gauge and stored under refrigerated (4°±1°C) and frozen (-10°C) conditions for 6 and 90 days, respectively. The samples were analyzed for pH, moisture content, TBA value, lipid profile

and oxysterols at regular intervals of 0, 3, 6 days and 0, 30, 60, 90 days under refrigerated and frozen conditions, respectively. The pH of both meats increased significantly during cooking. The pH of buffalo meat remained unchanged while that of mutton increased significantly during refrigerated and frozen storage. TBA value increased significantly due to heat processing in both the meats. Broiling always resulted in a higher TBA value compared to pressure cooking. On storage, there was a significant increase in TBA value and the change was more pronounced in refrigerated samples. Processing significantly increased total lipids, total phospholipids, total cholesterol, total glycerides, glycolipids and free fatty acid contents of both the meats.

The following cholesterol oxidation products were separated by thin layer chromatography viz., cholestanetriol, 7-alpha- hydroxycholesterol, 19-hydroxycholesterol, 7-ketocholesterol, cholesterol alpha and beta-epoxides and an unidentified fraction. The percentage of all the cholesterol oxides, except cholesterol beta-epoxide and unidentified fraction increased on heat processing in both the meats. The unidentified fraction decreased significantly, while the cholesterol beta-epoxide remained apparently unaffected. A significant increase in all oxysterols, except unidentified fraction was evident during refrigerated and frozen storage, whereas unidentified fraction decreased significantly during both the storages. It was concluded that stored cooked meat might be consumed with reservation.

APT-15 PHYSICO-CHEMICAL AND SENSORY QUALITIES OF MUTTON *PATTIES* INCORPORATING DIFFERENT LEVELS OF TEXTURIZED SOY PROTEINS AND HYDROGENATED VEGETABLE OILS

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The possibility of incorporating texturized soy protein (TSP) at 0, 10, 20 and 30 percent levels and hydrogenated vegetable oils (HVO) at 5, 10, and 15 percent levels to replace part of the lean in mutton *patties* was studied so as to evolve low cost formulation and low fat meat products. The emulsion stability and cooking yield increased ($P< 0.01$) with the increase of both TSP and fat levels. The shrinkage in diameter on cooking decreased ($P < 0.01$) with the increase in TSP levels, but increased with the increase in fat levels. The gain in weight was not affected due to the TSP levels but increased ($P< 0.01$) with the increase in fat levels. Shear force value decreased ($P<0.01$) with the increase in TSP and fat levels. The pH of emulsion increased ($P < 0.01$) as the TSP levels were increased, but decreased ($P < 0.01$) as the fat levels were decreased. There was a significant negative correlation between pH and the emulsion stability up to 10 percent TSP levels ($r = -0.77$ and - 0.83 for 0 and 10 percent TSP respectively). The moisture content of both raw and cooked *patties* decreased ($P < 0.01$) with the increase of both TSP and fat levels. The protein content was not affected due to TSP levels, but decreased ($P < 0.01$) with the increase in fat levels. Ash content increased with the increase in TSP levels, but decreased with the increase in fat levels. The sensory scores for colour and appearance remained non-significantly different ($P < 0.05$) due to TSP levels,

but improved ($P < 0.05$) due to fat levels and it was highest at 10 percent fat levels. Other sensory scores like flavour, juiciness, texture and overall palatability decreased ($P < 0.01$) as the TSP levels were increased but increased ($P < 0.05$) as the fat levels were increased. *Patties* containing 0 and 10 percent TSP were rated as good and those with 20 and 30 percent were rated as fair. Thus, the mutton *patties* of good physico-chemical and sensory qualities can be prepared incorporating TSP and HVO at the level of 10 percent each and substituting 20 percent lean without any adverse effect on protein content and overall sensory quality.

APT-16 SOME CHARACTERISTICS OF MECHANICAL DEBONED CHICKEN MEAT AND CHICKEN TRIMMING USED IN A LOCAL FRANKFURTER PRODUCTION

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Mechanical Deboned Chicken Meat (MDCM) and Chicken Trimming (CT) represent by-products from a poultry processing operation, which could be utilized in the production of frankfurters. Physico- chemical and proximate analyses were carried out on the raw materials as well as various combination of MDCM and CT formulations. As the level of MDCM increased (50, 60, 70 and 80 percent), percent fat, ash and peroxide values increased, while percent moisture, and protein decreased. No changes were observed for TBA and pH values. Colour measurement for L, a and b values showed a slight increase in a value (redness) and a slight decrease in L value (lightness) and b value (yellowness) as MDCM content was increased. This study showed that by-products such as MDCM and CT have favourable properties that make them useful in the production of values added products such as chicken frankfurters.

APT-17 GROWTH, CARCASS TRAITS AND MEAT COMPOSITION OF BROILER RABBITS IN HIMACHAL PRADESH

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In the present study, growth, carcass traits and meat composition of two breeds of broiler rabbits, viz., Soviet Chinchilla and New Zealand White were studied. The pure breeds were weaned at the age of 6 weeks. Their weekly weights were recorded and the animals were maintained under uniform feeding and managemental condition in flat deek type cages in the rabbit farm of the Department. The rabbits were slaughtered by zataka method at the age of 14 weeks, and dressed as per standard procedures. The carcass traits studied included dressing percentage, weights of edible and in-edible offals and weights of primal cuts. Proximate principles were analysed to study the meat composition. Weekly weight gain in New Zealand White and significantly lighter than Soviet chinchilla during 7th and 8th and 13th and 14th weeks. Amongst the carcass traits, weights of primal

cut force leg and skin were significantly higher in New Zealand White, however no significant differences were observed in meat composition of the two breeds.

APT-18 PROCESS DEVELOPMENT FOR DRYING OF CHANKMEAT (*XANCUS PYRUM*) AND ITS STORAGE CHARACTERISTICS

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In the standardisation of drying process for chankmeat (*Xancus pyrum*), among the three treatments tried, sample hot balanced at 3 percent salt solution for 20 min was found to be good. For comparative study, dried chank meat wafers available in local market were analysed for proximate composition, mineral contents, biochemical and microbiological characteristics. Storage characteristics of both laboratory and market samples were determined periodically for proximate composition, sodium chloride, water activity, TMA-N, TVB-N, FFA, peroxide value, Total plate count, fungal count, coliforms and organoleptic properties for a period of 150 days. Insect infestation was noticed in market samples within 90 days of storage period. There was a significant difference between the market and laboratory samples in the overall acceptability ($P \leq 0.05$).

APT-19 EFFECT OF STRAIN AND SEX ON THE DRESSING YIELD AND CUT-UP-PARTS OF BROILERS

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The present study was conducted to compare the broiler strains, PB-1, PB-2 and PB-4 (control) for dressing yield and carcass characteristics. The birds were reared under similar conditions on same feed composition and slaughtered at 8 weeks of age. Ten male and ten female birds from each strain were used. The data were collected for dressing percent as well as shank, head and giblet weights. The dressed carcasses were cut-up into neck, wings, thigh, drumsticks, breast and buck. The cut-up parts were expressed as percent of carcass weight, while shank, head and dressing percent were calculated on live weight basis. Males gave significantly higher live weights as compared to females except PB-2. Shank weights were significantly higher in case of males than females. Weight of head was also significantly higher in case of PB-1 and PB-4, while for PB-2, it was almost the same. The dressing percent was not significantly different for either of the strains. Percent yields of neck and wings were significantly higher for males, as compared to females for PB-1 and PB-4, while they were almost the same for PB-2. Percent thigh and drumstick contents were also significantly different between the male and female birds for either of the strains. Breast, the choice cuts yielded higher percent in case of females than males, but were almost same for PB-4

(control). The back portion was almost the the same for males as well as females, except for control, which gave higher value in case of males. PB-1 and PB-2 showed definite improvement over PB-4 (control), as far as, the characteristics evaluated are concerned.

APT-20 A NEW SIMPLE SPRAY WASHING TECHNOLOGY TO DECONTAMINATE SHEEP CARCASSES

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A simple and low cost spray wash technology was developed to decontaminate sheep carcasses. The spray wash technology consisted of a manually operated rocking sprayer with a free lance fitted with a pressure gauge at the lance end and a floodjet nozzle which emitted 4.5 L/min. under a pressure of 3 kg/cm^2 and receptacle for storage of chlorinated water. The spray wash was effected at a distance of 30.5 cm from carcass surface at an angle of 110^o for a duration of 30 sec. with chlorinated water (20 ppm). The effects of this spray wash technology on microbial load (Total Viable Count-TVC), organoleptic qualities, consumer assessment and shelf-life of mutton were assessed in comparison with potable water spray wash (0 ppm-PSW) and chlorinated water spray wash (20 ppm-CSW) on sheep carcasses (vertically split). There was highly significant reduction ($P<0.01$) in microbial load (TVC) of 89.85 percent consequent to CSW. The magnitude of reduction in microbial load was very high i.e. a TVC of 97.13 percent after 24 h of chiller storage (5 ± 2^oC) as compared to PSW during the same periods (TVC of 56.18 and 18.76 percent). A highly significant ($P<0.01$) difference in the reduction of TVC between PSW and CSW treatments on sheep carcasses was noticed. The organoleptic quality test for flavour, juiciness and tenderness and the consumer assessment for variations in flavour or taste of treated mutton revealed the absence of significant differences between PSW and CSW. The CSW treatment extended the refrigerated shelf-life of mutton by 21.20 percent as compared to PSW. The cost of application of CSW treatment on sheep carcasses was seven paise only per carcass when this spray wash technology was used. Hence, this low cost and simple technology could be recommended for routine adoption in slaughter-houses as a sanitary measure to produce clean meat.

APT-21 EFFECT OF FREEZING ON THE PROPERTIES OF ACTOMYOSIN FROM COMMON CARP (*CYPRINUS CARPIO*)

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The objective of this investigation was to assess the extent of changes in physico-chemical and functional properties of actomyosin from common carp as a result of freezing. The isolated actomyosin had a moisture content of 97.1 percent and nitrogen content of 0.42 percent. The ultraviolet absorption spectra showed that actomyosin was rich in aromatic amino acid residues. The solubility in 1M NaCl was reduced from 85.87 percent to 73.66 percent as the effect of freezing process. The aggregation phenomenon induced by freezing process was noticed as indicated by gel filtration profile on Sepharose-4B gel and by measuring reduced viscosity. The calcium activated ATPase activity decreased to 0.18 μg/mg protein/min as a result of freezing. The emulsion capacity of actomyosin was reduced by 30 percent after it was frozen. The initial aggregation as a result of freezing reduced the emulsion capacity of actomysin.

APT-22 THE ROLE OF SPICES AND MAILLARD REACTION PRODUCTS AS ANTIOXIDANTS IN MEAT PROCESSING

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Lipids are generally associated with flavour as well as defects in meat and meat products. Mincing, cooking, processing and dehydration enhance the oxidation of lipids in meats. In Indian continent, it is not a common practice to use cured meats for cooking and processing. Nitrite used in curing gives good antioxidative effect in meat products. On the other hand, it is more common to cook and eat meat along with various spices and condiments. Many of these ingredients including salt, exhibit various degrees of antioxidative and prooxidative effects. In this work, a comparative study was made on the antioxidative effectiveness of various spices, salt and certain Maillard reaction products produced from the interactions of sugar and amino acids in mutton and chicken lipids during processing. Among the spices studied, clove and cinnamon gave the maximum protection against oxidation. Effectiveness of salt was dependent on the concentration used. Antioxidative effect of Maillard reaction products was found to depend on the basisity of the amino acid and temperature and duration of heating. A similar behaviour was noticed in model systems comprising of methyl linoleate coated on cellulose matrix along with spices, oleoresins and Maillard reaction products. GLC and densitometric studies on the various fractions of glycerides and unsaturated fatty acids were also carried out to determine the extent of degradation. These studies indicated that, some of these spices and Maillard reaction products could be effectively used to minimise oxidation in meat and meat products.

APT-23 HIDE FLESHINGS FROM TANNERY - UNCONVENTIONAL SOURCE OF FEED INGREDIENTS

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Approximately 35 percent of limed fleshings of 80 percent moisture are available as wastes during the fleshing operation and the same shares the major constituent of the total tannery wastes. Invariably, selected quality of fleshings are utilised for glue production and the rest pose a problem of disposal. A simple and suitable method was developed at CLRI to convert these wastes into a protein meal. Proximate composition of hide fleshings meal was estimated and the percentage of protein was found to be 55-60 percent. Though the fleshing meal was deficient in certain amino acids like lysine, histidine, threonine etc., its biological value could be improved when feed ingredients rich in lysine histidine theronine etc. were incorporated into the compounded feed formulations. Fifty percent of the fish meal substituted with fleshing meal in the broiler feed formulations indicated that, the growth rates were comparable to control chicks fed with conventional feeds. High amount of collagen protein present in hide fleshings meal improved the texture and binding property of aqua feeds and also the quality of the pelleted feeds.

APT-24 ULTRASTRUCTURAL QUALITY OF IMPROVED AND INDIGENOUS POULTRY MEAT

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Three samples of breast meat from males aged 20 weeks of synthetic broiler strain and dark meat yielder Kadaknath were studied under scanning electron microscope. Broiler meat contained greater amount of collagen in between myofibrillar bundles with larger vacuoles rendered by fat globules of discountinuous phase. Descriptions of epimysium and endomysium were clearly demarcated. Pictures from Kadaknath, revealed meagre collagen, presence of melanin pigment grains (30 μm dia. approx). Epimysium and endo-mysium were not well spelled. Based on the observations, Kadaknath meat appeared to be a better choice for product development as compared to broiler at the stipulated age.

APT-25 STUDIES ON THE DEVELOPMENT OF INTERMEDIATE MOISTURE MEAT

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Mutton cubes were equilibrated in infusion solution containing humectants (glycerol and sodium chloride) and preservative (potassium sorbate) by desorption technique and then dried at 48- 50°C in air drier. The cubes were packed in metallised polyester bags under vacuum and stored at 37±1°C. Data were collected on isotherms, chemical, physical, microbiological and sensory profiles. The product showed an a_w of 0.85 and pH 5.60, which remained unchanged during storage period. Marginal decrease was observed in moisture content during storage period. Total plate count and yeast and mold counts were substantially reduced during storage period. *Salmonella*, *Staphylococcus* and coliforms were absent. Anaerobic count did not increase. TBA values did not indicate any sign of rancidity. Organoleptic evaluation revealed that, the product was shelf-stable, microbiologically safe and acceptable for a period of 2 months. Further, intermediate moisture meat was found to be suitable for preparations of mutton fry and meat pickles.

APT-26 INPUT AND OUTPUT OF ENERGY IN PROCESSING GIZZARD PICKLES

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Data were collected through 7 replicates to quantity the input of commercial energy in manual processing of oil based (OB) as well as vinegar-based (VB) chicken pickles and output of caloric values from the products was calculated. VB pickle required higher amounts of electrical (0.691 kWh) and total energy (9.792 MJ) per kilo of raw gizzards as compared to OB (0.597 kWh and 8.731 MJ/kg) pickle. However, the human energy consumption was more while preparing OB pickle (1.62 MJ/kg). Caloric yields were also greater from OB (282 cal./100g) in relation to those from VB (262 cal./100g) pickle. Based on the observations from experiments, the processing of VB gizzard pickle appeared to be cost effective (67 cal. per rupee) over OB (56 cal. per rupee) product.

APT-27 STUDIES ON EMULSION-TYPE BUFFALO BEEF (BUEF) SAUSAGES INCORPORATING SKELETAL AND OFFAL MEATS WITH DIFFERENT LEVELS OF REFINED GROUNDNUT (PEANUT) OIL

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Emulsion-type convenient buffalo beef (buef, a new word coined) sausages of acceptable quality were developed by incorporation 85 percent meat components (70 parts of skeletal meat and 30 parts of offal meats) with 15 percent refined groundnut oil. The emulsion stability, cooking losses of emulsions and sausages, composition of cooked sausages, eating quality of sausages and the microscopic characteristics of raw emulsion and cooked sausages were studied. The stable uncooked emulsion showed medium, small and fine oil globules surrounded by a fine and compact protein matrix under the microscope. While the stable cooked emulsion showed the oil globules being bound by fine coagulated protein matrix and myofibrillar network, the unstable cooked emulsion showed the collapse of bigger oil globules forming oil channels causing damage to the protein matrix. The developed sausages had a high emulsion stability (1.47 ± 0.48 ml oil released/100g emulsion); low emulsion cooking loss (10.73 ± 0.35 percent); a low sausage cooking loss (9.93 ± 0.44 percent) and a high overall acceptability.

APT-28 READY-TO-COOK/READY-TO-EAT SNACK-ENTERONS FROM SMALL INTESTINES OF GOATS

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Large quantities of intestines of slaughtered goats are wasted or under utilised. Hence, goat intestines were collected and processed into ready-to-cook (RTC)/ready-to-eat (RTE) meat foods called snack-enteron (SE) (a new word coined). Following slaughter, the goat intestines were collected, stripped, flushed, slimed, washed, cut into small strips and cured. The cured intestinal meat strips were dried initially at 70°C for 4 h and at $100° \pm 2°$C for 4 h to get the RTC SE. The RTE SE was obtained by frying at $230° \pm 5°$C for 1 to 2 sec. Upon subjecting to sensory evaluation by a trained laboratory panel as well as consumer panel, the product was found to be of good quality and acceptable nature. The percentage yield of RTC and RTE SEs were 14.83 and 18.07, respectively. The percent moisture, protein, ether extract and total ash of RTC SEs were 4.60, 71.45, 9.37 and 14.55, respectively; whereas those of RTE SEs were 1.64, 64.46, 20.59 and 13.31, respectively. Based on the cost of ingredients used, the cost of the product was worked out to be Rs.45.80/Kg for RTC and Rs.46.53/Kg for RTE snack-enterons.

APT-29 PROTEOLYTIC ACTIVITY OF FRESH-WATER FISH MUSCLE DURING CHILLED STORAGE

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Proteolytic activity in fresh-water fish (*Labeo-calbasu*) muscle was studied in sterile and non-sterile (control) conditions in fillets and homogenates stored at 2±1°C. Observations of almost same proteolytic activity in sterile samples as in non sterile (control) emphasized the dominant role of endogenous muscle proteases in the reaction. The rise of water-soluble fraction could account for the marked softening of the muscle during storage. As compared to changes in water- soluble proteins, the changes in tyrosine values were more subdued. Thus, endogenous proteases account for most of the proteolytic activity in fresh-water fish muscle during chilled storage.

APT-30 DEVELOPMENT OF RANCIDITY AND ITS CONTROL DURING FERMENTATION OF POULTRY OFFALS

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Poultry intestine consists of 7.2±2.7 percent ether extract which is highly susceptible to rancidity development. Fermentation process for ensiling of offal with molasses under microaerophilic conditions was studied by monitoring periodically the changes in pH, free fatty acids (FFA), peroxide value (PV), thiobarbutric acid (TBA) and iodine value (IV). Common salt at 2.5 percent was included to suppress the increase in volume of fermentation mixture. Ethoxyquin at 0.02 percent level was used to test its effect as an antioxidant. The initial pH 5.9±0.2 of offal was brought down to 4.0±0.1 within 48 h after homogenising with molasses and salt. The FFA values (as percent oleic) were in the range of 44-56 and no definite trend was observed during fermentation. Low TBA values (0.29-0.44 mg malonaldehyde/kg sample) indicated that, the samples were not rancid even on 10th day of storage. However, the PV and TBA scores were the same in both antioxidant and treated and untreated samples. On the other hand, the IVs (g iodine absorbed/100g oil) were higher (83-86) for antioxidant-treated samples compared to control (77-79) suggesting that, ethoxyquin was effective in controlling oxidation at the double bonds in fatty acid molecule.

APT-31 EFFECT OF CERTAIN ANTIDENATURANTS ON THE QUALITY OF RIBBON FISH MINCED MEAT DURING FROZEN STORAGE

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Antidenaturant properties of sugars and their combinations were used for preserving locally abundant, ribbon fish. The minced meat was mixed with sucrose-sorbitol, sucrose-polyphosphate, jaggery-sorbitol, jaggery-polyphosphate and frozen-stored. The biochemical analysis and gel forming ability were conducted at monthly interval over a period of 6 months. There was a gradual decrease in protein extractability and relative viscosity. Drip- loss and cook-loss increased steadily. *Kamaboko* prepared from each sample showed decrease in gel strength and overall acceptability; increase in expressible water percentage during storage period. Correlation between gel forming ability and protein solubility was high. These changes were controlled in varying degrees by the antidenaturants used. The cryoprotection was highest by jaggery-polyphosphate than others over control. Ribbon fish minced meat was suitable for gelly products and also could be frozen-stored for 6 months using jaggery-polyphosphate.

APT-32 INFLUENCE OF PRE-CHILL PROCESSING ON THE QUALITY OF SMOKED BUFFALO MEAT CHUNKS

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Several technological and economic merits were attributed to pre- chill (hot meat) processing. The present study was aimed to elicit the quality of pre-and post-chill processed smoked buffalo meat chunks. The biceps femoris muscles were excerised from the carcasses of adult female buffaloes of good finish. The muscles were cut into two halves. Half of the chunks assigned to pre-chill processing were cured within 6 h of slaughter. The cured chunks were smoked till a desirable attractive colour was attained. They were cooked in preheated hot air oven (160°C) to an interval temperature of 90°C. Cooked products were chilled, sliced and packaged in polyethylene bags. The chunks assigned for post-chill processing were chilled for 24 h at 4±1°C, cured, smoked and cooked similar to that of pre-chill processing. Cooking yield and moisture content of pre-chill processed chunks were significantly higher. Protein, fat, total and cured pigments, percent colour formation, residual nitrite, hue and chroma, and sensory attributes of pre-and post-chill processed products did not vary significantly. Both the products were highly acceptable. Pre-chill processing could be advocated for manufacturing cured as well as smoked buffalo meat products to save refrigerated energy, time and costs.

APT-33 EFFECT OF ETHYLENE DIAMINE TETRA ACETIC ACID (EDTA) AND ASCORBIC ACID OR SORBITOL ON STORAGE STABILITY OF GOAT AND BUFFALO MEAT DURING REFRIGERATED STORAGE

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In spite of the use of integrated and sophisticated hygienic measures, meat is still contaminated with high bacterial counts, sometimes with pathogens. The efficacy of the following chemical dip-treatments was investigated for reducing bacterial contamination and extending the refrigerated shelf-life of goat and buffalo meats - (i) 1 percent EDTA, pH 5.8-6.1 (ii) 1 percent EDTA + 1 percent ascorbic acid (E+A), pH 3.8-4.1 and (iii) 1 percent EDTA + 2 percent sorbitol (E+S), pH 6.1. Immediately after dip treatment, the initial reduction (log_{10}/g) for aerobic plate counts (APC) in E+A, E+S and EDTA treatments were 0.96, 0.75 and 0.38, for goat meat and 0.77, 0.38 and 0.34 for buffalo meat, respectively. The psychrotrophic counts (PPC) were reduced by (log_{10}/g) 0.72, 0.77 and 0.09 for goat meat and 1.42, 1.18 and 1.02 for buffalo meat in the three treatments, respectively. Overall, the E+A treatment showed significantly ($P<0.05$) lower counts compared to EDTA or its combination with sorbitol for APC and PPC in goat meat and for APC in buffalo meat. The colour, odour and overall acceptability scores indicated that, E+A treated goat and buffalo meats were acceptable throughout the storage period of 20 days, whereas the E+S or EDTA-treated meats were unacceptable after 15 days. The control samples were unacceptable after 10 days of storage.

APT-34 EFFECT OF TEMPERATURE OF CHEMICAL DIP CONTAINING EDTA AND ASCORBIC ACID ON STORAGE STABILITY OF GOAT MEAT DURING REFRIGERATED STORAGE

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A chemical dip treatment (pH 3.8 to 4.0) containing 1 percent EDTA and 1 percent ascorbic acid for 1 min at 50°C ($E+A_{50}$) was compared with that at 30°C ($E+A_{30}$) on microbial and sensory qualities of goat meat stored at refrigeration temperture. The untreated meat served as control. The treated meats showed lower microbial counts as compared with the control immediately after treatment and during storage. The temperature of the chemical dip had no significant effect on aerobic plate counts (APC), but a significant effect was observed on psychrotrophs (PP), *Pseudomonas* and *Lactobacillus*. There was also significant ($P<0.05$) differences in the slopes of linear regressions for APC, PP, and *Pseudomonas* count between $E+A_{50}$ treatment and control samples. The $E+A_{30}$ treatment showed significantly ($P<0.05$) lower TBA value as compared to either control or $E+A_{50}$ treatment. No off-odours were detected in treated samples thoughout the storage period of 15 days, while in control, distinct off-odours were observed after 10 days. When meat was

experimentally contaminated with *Salmonella typhimurium* or *S. anatum* (10^5/g), these organisms were recovered after the dip treatment.

APT-35 QUALITY OF FERMENTED MUTTON SAUSAGES AT VARIOUS STAGES OF PROCESSING

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In an effort to develop simple methodology for production of shelf-stable, ready-to-eat meat products through fermentation, employing lactic acid bacteria (LAB) as starter culture, the quality of fermented mutton sausages at various stages of processing was investigated. Main stages of processing included raw sausage preparation, their fermentation and drying under controlled conditions. Processing significantly affected the physico-chemical and microbiological parameters studied. The pH (4.6) and moisture (44.5 percent) reduction qualified the product as fermented dry sausage. The nitrite content of the sausages decreased, while the values of fat, protein, ash, cured meat pigment, non-protein nitrogen, free fatty acids and peroxide value increased during processing. The finished product, having a total count of 6.38, LAB of 6.30, yeast and mold of 4.59, coliforms of 1.98, *enterococci* of 5.12 and *S.aureus* of 2.38 Log_{10}/g, scored 6.46 for overall acceptability on an 8- point descriptive scale. Except for pH decline and growth of LAB during fermentation, the major changes occurred at drying stage. Results indicated that quickly ripened, low salt and low nitrite fermented sausages of good quality and microbial safety and stability could be produced.

APT-36 EFFECT OF PORK RIND ON THE QUALITY OF NUGGETS

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To produce pork nuggets economically, pork rind (skin), an edible by-product which was left over in the manufacture of prime quality pork nuggets or other processed products, was incorporated both in raw and cooked form in the formulations at 10 percent to replace the lean pork and studied for their acceptability. Control formulation had 85 percent lean pork and 15 percent fat. Primal cuts of shoulder, loin and ham were chilled at $4\pm1^{\circ}C$ for 24 h and deboned. Lean pork, fat and rind were minced separately. Part of rind was pressure-cooked for 5 min, cooked and minced. The emulsions made with lean pork, fat, rind, and additives in bowl chopper were filled in aluminium molds and steam-cooked for 30 min. The chilled meat blocks/loaves were sliced into nuggets and packaged in polyethylene bags. Emulsion stability and product yield did not vary significantly. Shear force values of the nuggets containing cooked rind were markedly higher. Nuggets containing raw rind were highly acceptable and comparable with that of control. The flavour, texture and overall acceptability of nuggets containing cooked rind were significantly lower than those of control.

Incorporation of raw rind could be advocated in comminuted pork products without significantly affecting quality.

APT-37 QUALITY OF RESTRUCTURED AND EMULSION FROM BUFFALO MEAT NUGGETS

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Production of convenience and value-added processed buffalo meat products is a way for profitable utilization of abundantly available low-cost buffalo meat from spent animals. The objective was to develop highly acceptable restructured and emulsion form, nuggets. Buffalo meat from round portion and fat obtained from adult female carcass were chilled for 22 h and minced. The emulsion, consisting of 90 percent meat and 10 percent fat along with additives, was made in bowl chopper. Meat batter for restructured nuggets, consisting of 75 percent chunks (2 cm) and 25 percent meat emulsion as binder along with additives, was made in food mixer using kneader. Meat emulsion/batter was steam-cooked in aluminium moulds. Chilled meat blocks/loaves were sliced with nuggets and packaged in polyethylene bags. Cooking loss of batter/emulsion, yield and moisture content of the products did not significantly vary between treatments. Although both the products were highly acceptable, the emulsion form, nuggets had better sensory attributes in comparision to restructured ones when they were made from tough meat. Emulsion technology rather than restructuring process could be efficiently used for converting tough buffalo meat from old animals into highly palatable value- added products.

APT-38 EFFECT OF SMOKING ON THE QUALITY OF CURED BUFFALO MEAT CHUNKS

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The objective was to find the effect of smoking on the acceptability of cured buffalo meat chunks. The biceps femoris muscles from the carcasses of adult female buffaloes were chilled for 24 h and cut into equal parts. The brine solution consisted of sodium chloride, nitrite, tripolyphosphate and sugar; curing was done by stich pumping the brine for 48 h at $4\pm1^{\circ}C$. Some of the cured chunks were smoked till a desirable attractive reddish brown colour was attained. Cured as well as smoked chunks were cooked in preheated hot-air oven to attain $90^{\circ}C$ internal temperature. Chilled chunks were sliced and packaged in polyethylene bags. Smoking did not significantly affect the cooking yield, pH, moisture, protein, fat, total and cured pigments, hue, chroma and residual nitrite content. Smoked chunks had significantly ($P<0.01$) better colour, flavour and overall acceptability. Application of smoking significantly improved the palatability of cured buffalo meat chunks which added variety to the meat-based fast foods.

APT-39 CONSUMER ACCEPTABILITY AND ECONOMICS OF INCORPORATING VEGETABLE BINDERS IN PORK CUTLETS

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A study was conducted to elicit consumer reactions on quality attributes in pork cutlets due to incorporation of (i) 25 percent cooked potato (ii) 25 percent cooked soya flour (iii) 15 percent potato and 15 percent soya flour and (iv) 20 percent potato and 40 percent soya flour to reduce cost of preparation in comparison to those made from a mix (standard recipe) with 50 percent cooked pork, 15 percent cooked potato and 35 percent onion, green chillies, spices etc. A 40 member consumer panel evaluated cutlets of all the batches for appearance, firmness, juiciness and taste on a 5 point scale. Addition of 25 percent potato resulted in a 20 percent decrease in cost of preparation with 5.4 percent increase in appearance, 10.5 percent increase in taste in comparison to standard recipe. Cutlets of (i) to (iv) batches recorded percentage decreases of 6.7, 16.7, 23.3 and 26.7 in cost of preparation and 8.3, 5.6, 8.3 and 8.3 in taste, respectively.

APT-40 QUALITATIVE DIFFERENCES IN PRE-RIGOR AND POST-RIGOR PROCESSED MEAT SAMPLES

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A study was conducted to evaluate quality differences between pre-rigor and post-rigor processed intermediate moisture (IM) meat samples. IM meat samples were prepared with buffalo meat in pre-rigor and post-rigor stages by equilibration, oven-heating and surface-drying and stored in polypropylene bags at ambient temperatures for two months. Percent yield was higher (51.2) in post-rigor processed samples than pre-rigor processed samples (47.0). Pre-rigor processed samples recorded higher water holding capacity in both uncooked and cooked states, Munsell chroma, soluble and extractable proteins and lower protein breakdown and TBARS values than post-rigor processed samples. However, differences in odour, tenderness, juiciness and flavour were not statistically significant.

APT-41 EFFECT OF LEVEL OF NUTRITION, STAGE OF MATURITY AND MUSCLE TYPE ON THE MINERAL CONTENT OF MALE BUFFALO CALVES

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Male buffalo calves at weaning stage (four months old) were reared on three levels of nutrition i.e., 100, 115 and 130 percent and slaughtered after 4, 8 and 12 months feeding. The LD, BF, TB and ST muscles were collected from the carcasses and analysed for minerals namely, zinc, copper, sodium, potassium, iron, magnesium, manganese and cobalt contents using atomic absorption spectroscopy. The data for various mineral contents were analysed for statistical significance with reference to effect of level of nutrition, stage of maturity, muscle type as well as various interactions The level of nutrition and stage of maturity had a significant effect on zinc, copper, sodium, potassium, iron and cobalt contents, while copper and cobalt contents were also significantly affected by muscle type. Magnesium content was affected by treatments and level of nutrition only, while manganese content was not affected by any of the treatments/ factors. It was concluded that key minerals like iron, copper, cobalt were affected by level of nutrition and stage of maturity of the male buffalo calves

APT-42 APPLICATION OF 5'NUCLEOTIDES IN FOOD PRODUCTS

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The flavour enhancing effect of 5'nucleotides in selected foods was evaluated alone and in combination with monosodium glutamate (MSG) (0-0.1 percent). Evaluation was done using a panel consisting of trained, semi-trained and un-trained members from CFTRI, Mysore. Mutton soup gave very good response with the addition of these compounds. The flavour contributed by the flavour nucleotide as well as MSG was rather masked by the original flavour in chicken noodles, though there was apparent enhancement of the flavour intensity. In tomato soup, the required flavour was obtained only with higher levels of the flavour compounds.

APT-43 IDENTIFICATION OF RAW MEATS FROM CLOSELY RELATED SPECIES. I. EFFICACY OF CIE FOR MEAT DIFFERENTIATION

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Differentiation of raw meats of bullock, buffalo, sheep, goat, pig and chicken by discontinuous counter immunoelectrophoresis using commercial rabbit antisera against serum proteins of these species or their serial two- fold dilutions was carried out. It was observed that cross-reactivity between two groups of closely related animals, i.e., bovine (bullock and buffalo) and capric- ovine (sheep and goat) was eliminated by using 1:2 dilutions of anti-bullock and anti-buffalo sera. The cross reactivity within the bovine group was also eliminated when 1:4 dilution of anti- bullock serum was tested against meat antigens from above species. However, cross-reactivity could not be eliminated between sheep and goat even by using their respective antisera at any dilution. Anti-pig and anti-chicken sera in undiluted forms gave precipitin lines only with homologous system.

APT-44 IDENTIFICATION OF RAW MEATS FROM CLOSELY RELATED SPECIES. I. EFFICACY OF CIE FOR DETECTION OF ADULTERATION LEVELS

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The discontinuous counter immunoelectrophoresis was used to detect the level of adulteration of homologous meat antigen mixed with different levels (zero, 25, 50, 90 and 95 percent) of meat antigen(s) from non-cross reacting heterologous species. An appropriate two-fold dilution of commercial rabbit antiserum, raised against serum proteins of an animal species, which did not cross-react with heterologous meat antigens was employed in the test. The minimum detection limits for homologous antigen in meat mixtures noticed were ≥5 percent for bullock (BL), buffalo (BF), goat (G), pig (P) and chicken (C) meat antigens while using 1:4 dilutions of anti-BL and anti-BF serum and undiluted anti-G, anti-P and anti-C sera, respectively. However, sheep meat as an adulterant could be detected at ≥50 percent level by using 1:8 dilution of anti-S serum. In general, higher the dilution of antiserum, poorer was the resolution.

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APT-45 ROLE OF BACTERIAL PROTEOLYSIS IN THE SPOILAGE OF FLESH FOODS

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Proteolytic enzymes are known to play a prominent role in the spoilage process, resulting in degradation of muscle proteins giving rise to total volatile acids (TVA) and total volatile bases (TVB). Myofibrillar proteins (MFP) isolated from Indian mackerel were subjected to varying doses of gamma radiation (0-5 kGy) and seeded with *Aeromonas hydrophila, Bacillus megaterium, Pseudomonas marinoglutinosa* and *Salmonella typhimurium*, followed by incubation at ambient temperature for 24 h. Growth of bacteria on irradiated and unirradiated MFP was similar. Proteolytic activity was determined from the supernatant using haemoglobin as substrate. Proteolysis expressed in terms of tyrosine release in TCA extract was reduced by 50-60 percent in irradiated MPF. Decline of protease secretion in bacteria ranged between 50 and 70 percent on irradiated MPF. A possible mechanism of inhibition in synthesis of proteases could be related to conversion of cysteine to cystine upon irradiation. The suppression in bacterial protease activity in irradiated flesh foods could be ascribed to decrease in available free -SH groups in muscle proteins.

APT-46 PROTEASE SECRETION AS A POSSIBLE MODE OF SURVIVAL OF *AEROMONAS HYDROPHILA* IN FLESH FOODS

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Aeromonas hydrophila is widely distributed in spoilt flesh foods. Nutrient broth-grown cells of this bacterium were harvested after incubation at 28°C on a rotary shaker, washed and suspended in 0.01M phosphate buffer of pH 7.2. During incubation, the starving cells were observed to secrete appreciable amounts of proteases; the amount increasing with higher cell concentration and also with higher amounts of added myosin. Trypsin-treated myosin elicited higher protease secretion. In contrast, irradiated fish proteins exhibited slower degradability with the protease of *A. hydrophila*. Characteristics of different proteases secreted by resting cells of *A. hydrophila* responsible for proteolysis of flesh foods using protease inhibitors is discussed.

APT-47 SENSORY AND MICROBIAL QUALITY OF BARBECUED RABBIT CUTS

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Fore and Hind quarters of six month old New Zealand white rabbits were barbecued using two recipes, with or without vinegar. The other common ingredients were 3 percent table salt, 0.25 percent turmeric powder, 0.1 percent black pepper and red chilli powder each, and 2.5 percent edible oil. Tomato ketchup at 7.5 percent was used as sauce. Salt and dry spices mixture were applied over the cuts before broiling at 175°C for one hour followed by barbecuing over charcoal fire at 150°C for 35 minutes with intermittent application of sauce. The analysis of variance revealed non-significant ($P<0.05$) difference in the scores of reciepes and cuts for appearance, tenderness, juiciness and saltiness. However, the scores of flavour and overall quality were sagnificantly ($P<0.05$) higher for recipe containing 10 percent vinegar.

Microbial quality indicated that samples without vinegar had mean SPC counts (cfu/g) of $3.34x10^2$ and $4.06x10^2$ on 0 and 8th day of refrigerated storage (5 ± 1°C) whereas the vinegar treated samples had the counts of $3.8x10^2$ and $2.2x10^2$ on these days, respectively. The samples were also examined for coliform counts on 0 and 8th day of refrigerated storage and were found absent.

APT-48 CARCASS AND CUTABILITY CHARACTERISTICS OF NEW ZEALAND WHITE RABBITS

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Six month old New Zealand white rabbits were evaluated for carcass and cutability characteristics to explore the possibility of developing variety products on pattern similar to chicken meat products. The mean preslaughter live weight was 1415.42 grams. The eviscerated carcass percentage was 51.23. The giblets were 5.65 percent of the live weight. The weights of liver, kidney and heart were respectively 79.25, 15.42 and 5.38 percent of the giblets. The weight of primal cuts i.e. Fore quarters, Hind quarters and Loin were 277.5, 287.5 and 160.0 grams which were 19.48, 20.26 and 11.29 percent of the live weight respectively.

APT-49 EFFECT OF VINEGAR ON ORGANOLEPTIC ACCEPTABILITY OF FRIED LIVER FROM RABBITS

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Three recipes were tried to improve the organoleptic acceptability of fried liver from rabbits and to encounter the repulsive typical inherent rabbit odour. Liver were cut into cubes of about 2.5x2.5x2.5 cm size, thoroughly washed and marinated for one hour with ingredients like 2 percent table salt, 0.5 percent turmeric powder, 1.0 percent spices mixture. The difference in the recipes were due to presence and/or absence of 5 percent tomato ketchup and 10 percent vinegar. Liver pieces were shallow fried with the help of 10 percent edible oil. After 5 minutes of frequent stirring the pan was covered with its lid pouring water at 10 percent level to allow simmering for another 3 minutes. Cooking yield of the vinegar treated samples (78.6 percent) was significantly lower ($P<0.05$) than the other two. The sensory scores of appearance, tenderness, juiciness and saltiness for all the three recipes were moderately good whereas the flavour and overall quality scores differed significantly ($P<0.05$). The 10 percent vinegar treated samples had superior effect on flavour and overall acceptability and was between moderately acceptable to very acceptable.

APT-50 MICROBIOLOGICAL QUALITY AND SENSORY SCORE OF TANDOORI CHICKEN STORED UNDER DIFFERENT CONDITIONS

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Tandoori chicken is a marinated and baked, ready-to-eat traditional poultry product. Pending sale tandoori chicken are usually kept in open or closed containers. Storage at ambient temperature allows growth of bacteria, yeasts and moulds. Unsaleable tandoori chicken are to be stored for short periods, to prevent economic losses and potential health problems. The present study was designed to test the effect of short holding periods, at different temperatures on microbial population, and sensory score of processed tandoori chicken. From the data obtained, it was observed that, tandoori chicken was at its best when prepared and served fresh. When some storage was inevitable, it can be stored at ambient temperature (20-25°C) for < 8 h. It can be stored at 4°C and -15°C for a period of 2 weeks. Refrigeration and freezing of baked tandoori chicken, though effective in assuring microbial safety, was ineffective in maintaining the characteristic cooked flavour of the product

APT-51 ISOLATION AND SELECTION OF MOLDS FOR MANUFACTURING RAW DRY SAUSAGES

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In an attempt to isolate and select molds for application as protective cultures in meat industry, samples were collected from air, installations and sausages from meat processing plants in Bulgaria. The molds isolated belonged to 3 families and 7 genera. Molds belonging to Moniliaceae constituted the dominant mycoflora. Nine strains of *Penicillum camemberti* were selected from the isolates for testing their suitability as starter and protective cultures. Based on the technological suitability studies, two strains were selected and compared with a strain of *Penicillium nalgiovensis*, a commercial mold culture from Federal Meat Research Institute, Kulmbach, Germany. The selected strains were used in semi industrial production trails of raw dry sausage "Sredna Gora". The sausages produced by using mold cultures were free from toxigenic and pathogenic molds and were protected against certain technological defects. It was established that the selected strains of *Penicillium camemberti* performed as well as *Penicillium nalgiovensis*.

APT-52 STORAGE STABILITY OF CHEVON PICKLE AT ROOM TEMPERATURE

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Chevon pickle using meat from culled-for-age Angora type bucks was prepared and its storage stability at room temperature (17.20±0.45°C; R.H. 52.60±1.67 percent) during the winter season was studied. After an interval of seven days, considered as maturation period, the product was evaluated for physico-chemical changes. Microbiological and organoleptic tests were carried out at an interval of 15 days upto a period of 60 days of storage. Initial mean pH and titrable acidity (percent acetic acid) of the product was 4.71±0.02 and 0.74±0.04 percent which reached 4.77±0.03 and 0.83±0.07 percent, respectively on 60th day of storage. Both Standard plate count and halophilic count decreased from $\log_{10}$4.14 and $\log_{10}$ 4.05/g on zero day to $\log_{10}$ 3.77 and $\log_{10}$ 3.80/g on 60th day of storage, respectively. Yeast and mold counts remained below 10/g throughout the storage period. Sensory attributes of the product remained satisfactory during the entire period of storage indicating that a good quality pickle can be prepared from old buck meat which can be stored for 60 days at room temperature.

APT-53 **STUDIES ON THE PREPARATION OF VERMICOMPOST FROM RUMINAL CONTENTS OF SLAUGHTERED ANIMALS**

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Rumen content (RC) consists of partially digested feed material consumed by animal before slaughter, along with rumen microorganisms suspended in liquid. Solid portion of RC cannot be disposed off in sewage treatment as it causes environmental pollution. Hence, studies have been conducted to convert RC into a value added product - vermicompost.

BIOTECHNOLOGY AND MICROBIOLOGY

BTM-1 ENZYME-BASED BIOSENSOR FOR ESTIMATION AND MONITORING OF GLUCOSE IN FERMENTATION PROCESSES

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In recent years, there has been an increasing interest in the development of efficient enzyme electordes for the estimation of physiologically and biotechnically relevant substances. Enzyme electrodes being specific are best employed in conditions, wherein minimal sample preparations are required with least interference from other chemically related substances. Hence, here an amperometric-based biosensor has been developed to detect glucose in fermentation process. Various membranes and immobilization techniques were used and Glucose Oxidase enzyme (GOD) was immobilized by physically entrapping it between membranes and chemically binding it to an inert protein and Bovine Serum Albumin. This method of immobilization yielded best results in terms of stability, reproducibility and less leaching of the enzyme through the membrane.

The enzyme membrane was found to be stable for nearly two months when stored at room temperature. The activity of immobilized GOD was measured from the catalytic current produced at controlled potential which, in turn, was electronically detected and measured. The bio-chemical reaction is as under:

$$\text{Glucose} + O_2 + H_2O \xrightarrow[\text{(GOD)}]{} \text{Glucanolactone} + H_2O_2$$

A good linearity of glucose estimation was found with this enzyme electrode in the range of 100/μg/ml (0.5 mM) to 5000/μg/ml (27 mM) with a regression value of 0.993. The regression value for 0.5/μg/ml (2.7 mM) to 50mg/ml (277 mM) glucose concentration was found to be 0.947. Thus, this developed enzyme-based biosensor was suitable to monitor glucose level in fermentation broth/extract.

BTM-2 EFFECT OF SODIUM HYPOPHOSPHITE ON SPOILAGE AND PATHOGENIC MICROFLORA OF DRESSED CHICKEN

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Studies were conducted to observe the effectiveness of sodium hypophosphite (SHP) in reducing the food pathogens like *S. aureus*, *streptococci*, coliforms, yeasts and molds on chicken carcasses and corresponding increase in their refrigerated shelf-life due to overall reduction in the inherent contaminants. Dressed chickens were dipped in different levels of SHP ranging from 0.3 to 2.0 percent for varying periods of 1 to 10 min. The treated carcasses were packed individually in LDPE bags and stored at $5\pm1^{\circ}C$. They were microbiologically analysed at appropriate intervals for different organisms as stated above, in addition to total aerobes, till the off-odour developed. The results obtained in this study revealed, that SHP treatment at 2.0 percent level for at least one minute could effectively reduce the total counts, thereby increasing the refrigerated shelf-life of treated dressed chickens over control samples. Coliforms and *streptococci* recorded a significant reduction in their counts, while *S. aureus*, yeast and molds were not affected significantly by any of the levels of SHP (from 0.3 to 2.0 percent) used in the present study.

BTM-3 STUDIES ON MECHANISM OF SOLID PARTICLE DEGRADATION BY *BACILLUS COAGULANS* IN SOLID STATE FERMENTATION

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Mechanism of solid particle (wheat bran) degradation was studied employing *Bacillus coagulans* NK1 which could produce higher titres of thermostable alpha-amylase solid state fermentation. The physical changes, such as size and weight reduction of the particles, water-holding capacity, moisture level and major enzymes responsible for the particle degradation were analysed at different hours of fermentation. At the initial period of fermentation, the organism utilized smaller sized particles having high starch content and the degradation was followed on larger sized particles in subsequent hours of fermentation. Both the weight and size of the solid particles were reduced considerably during this period and also increases in activity of the major hydrolytic enzymes like alpha-amylase and xylanase were observed. Cellulase and amyloglucosidase activities were not observed during fermentation. Microscopic studies revealed that *B. coagulans* occupied inner space of the cells of the particles. About 15 percent increase in water holding capacity of the substrate particles was observed at the end of fermentation.

BTM-4 RICE BRAN AS A SUBSTRATE FOR PRODUCTION OF CITRIC ACID BY *ASPERGILLUS NIGER* IN SOLID STATE FERMENTATION

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Exploratory studies on the use of rice bran for production of citric acid by *Aspergillus niger* CFTRI 30 in solid state fermentation showed 115.9 g citric acid/kg rice bran. Supplementation of rice bran with mineral salts improved citric acid production by about 9 percent. Enrichment with 0.05 percent ammonium sulphate had no effect, whereas citric acid production was decreased with the use of higher concentrations. Enrichment with 5% sucrose resulted in marginal improvement of citric acid production, but at the cost of conversion based on total initial sugar. Use of high concentrations of sucrose resulted in lower conversions and increased fermentation time by lower conversions and increased fermentation time by 1-2 days. Incorporation of cellulase, hemicellulase, amylase and pectinase in the medium had no effect. Citric acid production was decreased by 22 percent with the use of deoiled rice bran. Economic analysis of the data in terms of cost of rice bran oil produced during oil recovery and citric acid reduced during fermentation of deoiled rice bran indicated gain of Rs. 1440/tonne of rice bran when it was used sequentially first for extraction of oil and then for production of citric acid.

BTM-5 CHARACTERIZATION OF EFFLUENT FROM PADDY PARBOILING PLANT

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Soaking of paddy, particularly prolonged soaking, in the parboiling process results in leaching of nutrients and other water soluble substances that encourage growth of microorganisms. These substances, besides microbial metabolites, in the soak water may render the water unsafe and unusable. Thus, about 0.7 m^3 of effluent was produced per m^3 of paddy containing varying amounts of leachates and increasingly reduced dissolved oxygen content. When off-loaded, this effluent may have adverse effect on aquatic life of ponds, rivers etc. The characterization of the effluent was made to find out a suitable method for its safe disposal. It was found that total solid contents vary with soaking conditions. The pH was found to vary from 4.13 to 4.87 which was slightly less than the desirable range of pH i.e., 5.5 to 9.0. The biological oxygen demand and chemical oxygen demand, 410-600 mg/l and 720-1400 mg/l, respectively, were found to increase with increase in total solid contents. The characterization of the effluent and comparison of this with characteristics of the disposable effluent revealed that some suitable treatment must be given to the effluent prior to its disposal. Aerobic biological treatment by developing a trickling filter is in progress.

BTM-6 **AN ORANGE JUICEBORNE DIARRHOEAL OUTBREAK DUE TO ENTEROTOXIGENIC *ESCHERICHIA COLI***

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Diarrhoeal outbreak at Faridpur in Bareilly was reported in June, 1992. During the investigation, patients were interviewed and orange juice, sugarcane juice, and water samples as the suspected vehicles were collected alongwith stool samples of patients. On screening of all the collected samples, the enterotoxigenic *Escherichia coli* (ETEC) and enterotoxigenic *Klebsiella pneumoniae* var. *aerogenes* were isolated from all orange juice and sugarcane juice samples, but not from water samples. From all the patients with cholerogenic syndrome, ETEC were isolated from their stool samples. All the ETEC isolates from patients and an isolate from orange juice sample of a shop were identified as having the same antibiogram, that is, resistant to cotrimoxazole, carbanicillin, doxycycline, streptomycin, tetracycline and sulphonomides and sensitive to neomycin, gentamycin, nitrofuradentoin, polymyxin B, nalidixic acid and kanamycin and all remained untypable with the specific O- antisera. One ETEC isolate of 0134 serotype with multiple drug resistance was also isolated from a sugarcane juice sample in the outbreak. Isolation of ETEC from orange juice sample is of great public health importance as the affected persons had taken orange juice from the shop.

BTM-7 **PRESENCE OF COLIFORMS IN THE FOOD SERVED IN COLLEGE GIRLS' HOSTELS OF UDAIPUR CITY**

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Coliform load of food served in the girls hostel of a college in Udaipur city was assessed. Samples of individual food items served at lunch and dinner viz. rice, dhal, *chapati*, vegetables and curd were examined individually and also in pooled form. Coliform count was high in curd samples (40.0 cfu/g), followed by rice (18.33), vegetables (10.20), dhal (2.56) and *chapati* (0.65). When the pooled samples (prepared by taking equal quantity of each individual item) were analysed, average coliform count was 28.50 cfu/g.

BTM-8 EFFECT OF PROCESSING AND STORAGE ON THE BACTERIAL QUALITY OF EDIBLE OYSTER

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Bacterial quality of edible oyster, *Crassostrea madrasensis* (Preston) during various stages of processing and storage was studied. Oysters were cleansed to an acceptable level of faecal coliform within 24 h. Pathogens such as aeromonads, *staphylococci, vibrios* and *salmonallae* were persistant even after 24 h of depuration. The process of shucking increased the total plate count by 12 folds. Freezing and frozen storage decreased the bacterial load. Motile aeromonads remained viable in oyster meat even after 150 days of storage at 18°C.

BTM-9 OPTIMAL CULTURAL CONDITIONS FOR ANTIMICROBIAL ACTIVITY OF LACTIC ACID BACTERIA

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The consumption of fermented milks in controlling intestinal disorders has been attributed to the antimicrobial properties of lactic acid bacteria (LAB). The objective of the present study was to isolate antagonistic LAB cultures from fermented milks and evaluate optimal conditions for antimicrobial activity. Culture filtrates of 14 natural isolates of LAB obtained from samples of *dahi* and market raw milk were found to possess inhibitory effect against one or more of the following: *Staphylococcus aureus*, *Bacillus. macerans Klebsiella* spp. and *Pseudomonas aeruginosa*.

Among the growth media evaluated, reconstituted (10 percent) non- fat dry milk supplemented with 0.5 percent, each of yeast extract and glucose supported good growth of LAB and resulted in a strong degree of antimicrobial activity in 30 h at 37°C. The inhibitory effect was initiated at 18 h of incubation and the degree of inhibition increased upto 48 h. The antimicrobial principle was proteinaceous in nature and to a certain extent there was the involvement of hydrogen peroxide. The antimicrobial acitivity was heat stable (75°C for 30 min). The study revealed the suitability of growth medium and culture conditions to obtain good antimicrobial activity for potential antagonistic LAB cultures.

BTM-10 FATE OF FOODBORNE BACTERIAL PATHOGENS IN *KADHI*

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Kadhi, a popular indigenous fermented milk product, having mild acidic characteristics, is prepared by boiling of *dahi* with Bengalgram flour paste and is used as a culinary food item. Considering the practices followed in the preparation of *kadhi*, there are chances for bacterial pathogens to occur as pre- and post-processing contaminants. The fate of these organisms in *kadhi* prepared using selected antagonistic *Lactobacillus* spp. has been the subject of this study. Pathogenic cultures of *Staphylococcus aureus*, *Bacillus cereus* and *Escherichia coli* when introduced both as pre- and post-processing contaminants at levels of 1, 2 and 3 $\log_{10}$ cfu/ml, failed to survive and grow in *kadhi* prepared using antagonistic isolates of *Lactobacillus delbruecki* ssp. *bulgaricus*, *Lb. delbruecki* ssp. *lactis* and *Lb. helveticus*, individually. However, these pathogenic cultures were able to survive and grow in *kadhi* prepared by using non-antagonistic cultures of *Lactococcus lactis* ssp. *lactis* and *Lc. lactis* ssp. *cremoris* and market *dahi*. The study highlights the potential use of antagonistic cultures of *Lactobacillus* spp. in the preparation of microbiologically safe milk-based products.

BTM-11 MICROBIOLOGICAL CHARACTERISTICS OF PRAWN PICKLE

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Microbiological characteristics of prawn pickle stored at ambient temperature, (30°C) was studied. In prawn pickle with a pH around 4.75, the total viable count decreased to one-fifteenth over 60 days and the count ranged between 10^2 and 10^3 per gram. No lactic acid bacteria, coliforms, *Staphylococcus aureus*, *salmonellae*, *vibrios* and *Clostridium perfringens* were encountered. Counts of anaerobic spore formers and anaerobic gas producers increased with increase in storage period. Surviving bacterial isolates were found to be highly salt and acid tolerant. The product was organoleptically sound and did not show any visible signs of spoilage for a period of 270 days.

BTM-12 PRODUCTION OF ETHANOL FROM SORGHUM (*SORGHUM VULGARE*)

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Ethanol from starchy grains is very ideal for potable purposes and is economical to produce ethanol from such grains, which are no longer consumed by many people, as the tendency is to shift to finer grains like wheat and rice. One such minor cereal is sorghum whose annual production in the country is around 15 million tons. Due to the discolouration during storage, these grains become unattractive and hence unacceptable for use. Therefore, its use for ethanol production was investigated. Analysis of sorghum showed 10 percent moisture and 63 percent starch. The grains after powdering to 40 mesh particle size were used for ethanol production employing, acid-enzyme and enzyme- enzyme liquefaction and saccharification processes. The slurry containing 20, 25 and 30 percent solids on liquefaction and partial saccharification by the latter process and subsequent fermentation by simultaneous saccharification and fermentation, resulted in ethanol yield of 6.1, 8.5 and 9.7 gm percent, respectively with no residual sugar in the brew, whereas fermentation of slurry containing 20, 25 and 30 percent solids after acid-enzyme process resulted in the ethanol yield of 5.1, 7.5 and 8.7 gm percent, respectively with residual sugar of around 1.0 percent after 72 h fermentation at ambient temperature, thereby indicating the superiority of the enzyme- enzyme process. Both enzyme-enzyme and acid-enzyme processes showed maximum fermentation efficiency with 25 percent solids in the slurry. Hence, large batch of 5 litre slurry each with 25 percent solids was fermented employing enzyme-enzyme and acid- enzyme processes for ethanol production, and the fermentation efficiency of 94.47 and 87 percent, respectively, after 72 h fermentation. The data compiled indicate the potential of ethanol production employing sorghum grains.

BTM-13 GROWTH OF *AEROMONAS* SPP. IN MEAT

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Motile aeromonds are now being associated with gastroenteritis in human beings. Experiments were, therefore, carried out to study the possibility of growth of *Aeromonas hydrophila* and *Aeromonas caviae* in goat meat on storage at 28°C and 8°C temperatures. Both the species were able to multiply at the given temperatures. The microorganisms generally showed increases in numbers during the first 48 h. The number per gram of two isolates of *A.hydrophila* increased from 10^6 to 10^{11} and from 10^4 to 10^{12} at 28°C. At 8°C, the increase was from 10^6 to 10^9 and from 10^4 to 10^7 per gram. Similarly, *A.caviae* increased from 10^6 to 10^{11} at 28°C and from 10^6 to 10^9 at

8°C. The peak levels of bacterial population at 48 h were followed by a steady decline. It was inferred that the two species of *Aeromonas* were capable of growth in goat meat.

BTM-14 EFFECT OF MICROORGANISMS ON OIL QUALITY OF CRUCIFERS

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Seeds of crucifers are associated with large number of microorganisms which are present either inside or on the surface of the seeds. The chemical nature of the seeds might get altered due to the production of mycotoxic substances. The present study deals with the effect of microorganisms on oil content, protein content, iodine value and fatty acid composition. Healthy and unhealthy (presence of micro-organisms) seeds of eleven cultivars of crucifers from amongst (*Brassica juncea*, *B. campestris*, *B.napus*, *B.chinensis*, *Eruca sativa and Raphanus sativus*), were taken. Oil content, protein content and iodine value in the seeds were found to be reduced greatly due to the presence of microorganisms. The presence of microorganisms also affected fatty acid composition. Both saturated (palmitic and stearic acid) and unsaturated (linoleic acid) fatty acids were observed to have increased concentration in diseased seeds as compared to healthy seeds in all the cultivars studied. Oleic acid responded differentially. In some cultivars, it was observed to increased while in some it decreased. The levels of erucic acid which was the major fatty acid of crucifers were reduced in unhealthy seeds of all the cultivars.

BTM-15 PRODUCTION OF SCLEROGLUCAN BY *SCLEROTIUM ROLFSII*

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Scleroglucan is a microbial polysaccharide of capsular type secreted by the mycelia of *Sclerotium* sp. It is a neutral glucan of pseudo-plastic nature which has wide range of commercial application in agriculture, recovery of petroleum products, pharmaceutical and in food industry. In our laboratory, optimization of cultural parameters for scleroglucan production was carried out using *Sclerotium rolfsii*. The fungus was found to produce the polysaccharide under submerged fermentation of glucose, sucrose, fructose and also molasses. However, maximum conversion of 55 percent was obtained in media containing glucose. The synthesis of scleroglucan was found to proceed for 6 to 7 days along with mycelial growth, till the pH of fermented broth dropped to 2.0. Effect of various cultural parameters on the production of scleroglucan and the process involved will be presented.

BTM-16 SOME PROPERTIES OF PULLUNASE ENZYME FROM FUNGAL AND BACTERIAL ISOLATES

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Extracellular pullulan hydrolysing activity was detected in fungal and bacterial isolates by using sucrose as a carbon source. The crude enzyme showed optimum specific activity (U/mg of protein) at the end of 48 and 72 h for bacterial and fungal isolates, respectively. The optimum pH levels for bacterial and fungal activity were 5 and 6, respectively. The bacterial enzyme was more stable at higher temperature compared to fungal. Both the enzymes were more specific towards pullulan substrate compared to others. The results will be presented in detail.

BTM-17 CAMPYLOBACTERS IN FOODS OF ANIMAL ORIGIN

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The present study was aimed to determine the carriage rate of thermophilic campylobacters (*C. jejuni*, *C. coli*) in the samples of poultry meat (100), edible organs (liver, heart) of poultry (101), egg shell (102), egg yolk (102), sheep meat (102) and edible organs (liver, kidney) of sheep (102). Twenty two percent samples of poultry meat, 26.7 percent of edible organs of poultry, 0.98 percent each of meat and edible organs of sheep were found to have contamination of campylobacters. However, all the samples of egg shell and egg yolk were free from these organisms. Bio-chemical characterization of isolated campylobacters speciated them into *C. jejuni* biotype 1 and *C. coli* biotype 3. All the isolates of *Campylobacter* (24 of *C. jejuni*, 7 of *C. coli*) tested to 16 antimicrobial agents, were sensitive to gentamycin, streptomycin and nalidixic acid.

BTM-18 PREVALENCE OF AEROMONADS IN EGGS AND MEAT

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In order to determine the prevalence of aeromonads, a study was conducted on 609 samples of eggs and meat. The percent of different samples positive of aeromonads was 37.2, 32.6, 28.0, 24.0 and 0.98 of sheep meat (102), edible organs (liver & heart) of poultry (101), poultry meat (100),

edible organs (liver & kidney) of sheep (102) and egg yolks (102), respectively. None of the sample of egg shell (102) was positive for these organisms. A total of 125 isolates obtained from positive samples, were speciated into 77 of *Aeromonas. hydrophila*, 5 of *A. sobria* and 43 of *A. caviae*. Out of 27 representative isolates, enterotoxin production was detected in 66.67 percent and hemolysin in 62.96 percent isolates. *A. hydrophila* and *A. sobria* isolates were more enterotoxigenic and hemolytic than *A. caviae* isolates. A high percentage (73.6 - 88.0) of isolates were found sensitive to gentamycin, chloramphenicol, nalidixic acid and cotrimoxazole.

BTM-19 STUDIES ON CONSERVATION OF NUTRIENTS IN POULTRY WASTE BY FERMENTATION PROCESS

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Poultry industry is growing rapidly in India. Large quantities of waste material such as poultry intestines generated during poultry processing are rejected at present which cause waste of nutrients and environmental pollution. The material is highly perishable due to high microbial load. A fermentation process may be useful for preserving the nutrients in poultry intestine, especially in tropical countries like India. Studies were, therefore, conducted on the optimisation of levels of molasses, salt and antimycotic agents that effect fermentation at ambient temperature and microaerophilic conditions. Data were collected on microbial succession, pH and titrable acidity during fermentation. Treatment of poultry intestine with 10 percent molasses gave best results and the desired pH was achieved in 24 h. Spoilage and pathogenic microorganisms were inhibited during the early stages of fermentation and that the counts were reduced subsequently. Salt at 2 percent level was more effective to bring down coliform counts drastically in 48 h and counts were further reduced to zero levels. Propionic acid was found to be effective in controlling yeast and molds during fermentation process. The results demonstrate that fermentation process was effective in controlling spoilage and pathogenic organisms in the waste material.

BTM-20 KINETICS OF HEAT INDUCED DISINFECTION ACTIVITY OF CETYLTRIMETHYLAMMONIUM-BROMIDE

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Inactivation of microorganisms is important in many industrial applications. In the dairy and food industries, the quaternary ammonium compounds have found wide use as antimicrobial agents. The kinetics of microbial death by combined treatment of heat and cetyltrimethyl-ammonium bromide (CTAB), a cationic surfactant of quaternary ammonium compound was investigated. The presence

of CTAB remarkably enhanced the death of *Escherichia coli* cells, when suspensions of bacterial cells in 0.25M phosphate buffer solution (pH 7.0) were subjected to combined treatment with heat and CTAB at temperature range 35° to 50°C. The rate of survival was observed as almost linear, proportional to temperature. Different thermodynamic constants have been determined. Activation energy was 16,000 Cal/mol. Bacterial reduction was from $3x10^9$ cells/ml to almost zero. Activation energy was approximately equal to activation enthalpy at the temperature employed in this study.

BTM-21 PRODUCTION OF WINE FROM MANGO PULPER WASTE MATERIALS

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The possibility of production of wine from mango pulper waste material was investigated. The fibre rich solid waste was treated with 100 ppm of sulphur dioxide, 40 mg/kg of a commercial pectin enzyme "Biotropicase", pressed after 24 h and ameliorated with cane sugar to 22°Brix. Fermentation of this saccharine extract with a montrachet strain of *Saccharomyces cerevisiae* var. *ellipsoides* produced acceptable quality wine with mango flavour. Fermentation at 20°C resulted in better quality wine with more aroma retention as compared to 25°C fermentation.

BTM-22 CONTAMINATION SOURCES AND QUALITY OF MARKET *KULFI* AND MILK-ICES

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A study was undertaken to ascertain the source of contamination at various stages of processing of *kulfi* and milk-ices and microbial quality of finished products drawn from three randomly selected local manufacturers. Microbiological count for worker's hands, pasteurization equipment, empty containers, deep-freezer and marketing trollies showed highly significant differences ($P<0.01$) for coliform, yeast and molds between sources and samples. At processing stage, SPC ($x\ 10^5$), coliform count ($x\ 10^2$), *Staphylococcus* ($x\ 10^3$) and yeast and mold counts ($x\ 10^3$) ranged from 0.72-2.09, 0.13-8.83, 1.27-7.38, 0.10-1.85, respectively, for *kulfi* samples and 0.46-2.42, 0.5-5.0, 3.29-9.21, 0.76-1.53, respectively, for milk-ices samples. At marketing stage, the counts ranged from 3.06-27.50, 1.11-29.10, 6.42-20.40, 1.19-13.20, respectively, for *kulfi* samples; whereas the range for milk-ices were from 3.92-21.50, 6.20-29.30, 7.76-29.00, 4.78-18.60, respectively. Between the sources, samples and processing stages of both the products were found to be highly significant ($P<0.01$). The hygienic condition at processing, storage and marketing stages were found to be far from satisfactory.

BTM-23 **MODELLING DIFFERENCES IN RECOVERY POTENTIALS OF TWO STRAINS OF HEAT-INJURED *LISTERIA MONOCYTOGENES***

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The use of predictive models to determine potential hazards due to abuse of food products is presently an active field. The specific objectives of this investigation were to examine the recovery potential of two milk derived strains (F5069 and F5027) of *Listeria monocytogenes* after sublethal heat treatment and develop mathematical models for the recovery. The strains were heat-injured at 56°C for 20 min. with an average injury of 97.3 percent. Injured *Listeria* were recovered in *Listeria* Repair Broth under controlled environmental conditions using a fractional 3x3 factorial design (T = 22, 37 and 43°C; pH = 5.0, 6.6 and 8.0; and NaCl at 0.5, 2.5, 5.0 percent). Growth data from both selective and non-selective media were fit to the Gompertz equation to obtain kinetic parameters for each set of factor combinations designed (average R^2 of 0.997). The heat-injured *L. monocytogenes* recovered faster as pH increased and salt content decreased. With the exception of F5027 at 43°C, the injured strains recovered faster at higher temperature. There was no significant difference (alpha=0.05) in mean recovery time between the strains while varying pH, salt content and temperature. However, a greater variability in the recovery time was observed to be associated with F5069 which indicated that the recovery of this strain was more sensitive to environmental changes. A first order kinetic model was found suitable to describe the recovery of heat-injured *L.monocytogenes*. Predicted values using the combined Gompertz/first order model agreed well with the repair of heat- injured *L.monocytogenes* in milk as previously reported.

BTM-24 **ANTIMICROBIAL ACTIVITY OF SPICE ESSENTIAL OILS**

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The antimicrobial activity of seven essential oils from various spices was tested and compared with eugenol for yeasts, mold and bacteria. All the spice essential oils from ginger, cumin, ajawain, coriander, basil, clove and mustard showed various degrees of inhibition against *Aspergillus niger*, *Saccharomyces cerevisiae*, *Mycoderma* spp. *Lactobacillus acidophilus* and *Bacillus cereus*. *Mycoderma* spp. was the most susceptible, while *Bacillus cereus* was most resistant towards all the spice essential oils when tested by filter paper disc diffusion method. Maximum antimicrobial activity was observed in allyl-isothiocyanate (volatile oil of mustard) at different temperatures. In spicy products, spice essential oils in very small quantities will not only increase the palatability of food, but will also check the microbial spoilage during storage.

BTM-25 SCREENING OF FUNGAL CULTURES FOR THE PRODUCTION OF CELLULASE BY SOLID STATE FERMENTATION

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Cellulases produced by fungi have a high practical potential. Earlier studies on cellulase production have shown that the nature of carbon source is a most important factor in determining the effectiveness of economy of the inductive production of the process. With this in view, attempts were made for screening fungal cultures capable of producing very high titres of cellulase by solid substrate fermentation (SSF). About 70 different fungal cultures were screened for the production of cellulases by SSF using wheat bran as substrate. The cultures screened include different species of *Aspergillus*, *Penicillium* and *Trichoderma*. Except one, all the other cultures screened, produced very low cellulase activity (1 to 4 FPU/g dry moldy bran). One fungal culture belonging to *Trichoderma* isolated from the soil of a local paper industry, produced very high titres of cellulase (29 FPU/g DMB) on the 5th day of fermentation. This strain was compared for cellulase production both by SSF and submerged fermentation system and its potentiality was assessed.

BTM-26 PHOTOPRODUCTION OF HYDROGEN AND BIOMASS GENERATION BY PHOTOSYNTHETIC BACTERIA FROM EFFLUENT OF MANGO PROCESSING INDUSTRY

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Numerous prokaryotes belonging to physiologically and taxonomically different groups are able to produce hydrogen. Some photosynthetic bacteria have the property of light dependent production of hydrogen from suitable organic substrates. Several photosynthetic purple bacteria were isolated from enrichment cultures made from the waters of waste water ponds, fresh water ponds and from effluents of food processing and drugs manufacturing industries. After testing them for their ability to use various organic and inorganic compounds as carbon source and electron donors, a few *Rhodopseudomonas* species from mango effluent for their ability to produce molecular hydrogen were tested in presence of light. Hydrogen photo production in both free cells and sodium alginate immobilized cells were studied for more than a week. Approximate strategy necessary for the treatment of food processing waste and similar industrial effluents for energy reclamation is discussed.

BTM-27 HIGH ETHANOL PRODUCTIVITY PROCESS FOR ETHANOL PRODUCTION BY IMMOBILIZED CELLS OF *ZYMOMONAS MOBILIS*

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Recently, the potential of *Zymomonas mobilis* for ethanol production has been demonstrated by several research groups. In order to reduce the fermentation cost, the reaction rate may be increased by immobilization of the cells of *Zymomonas mobilis*. The entrapment of cells in natural polymers is most simple and widely used.

In the present investigation, ethanol production by entrapped cells of *Zymomonas mobilis* ZM4 in calcium alginate and open pore agar (OPA) was compared using repeated batch experiments. The open pore agar gel was found to be superior due to selective leaching of calcium alginate and agar-agar. In sixth repeated batch experiment, an overall ethanol productivity of 10.2gl^{-1} h^{-1} and 7.5 gl^{-1} h^{-1} was obtained from sucrose and molasses, respectively and the beads were found to retain their shape. Based on this performance, the cells entrapped in OPA were used for continuous ethanol production in packed bed reactor using sucrose (100gl^{-1}) and molasses medium (100, 150 gl^{-1} sugar conc.). Volumetric ethanol productivity (Q_P) of 21.4 gl^{-1} h^{-1} was obtained with ethanol yield of 0.46 gl^{-1} and 93 percent consumption of sugars at dilution rate (D) of 0.5 h^{-1} from molasses (100 gl^{-1} sugar conc.). This preparation has shown consistant performance for more than 50 days in continuous reactor. A complete analysis of the data with respect to the kinetics of the immobilized cells will be presented.

BTM-28 BEHAVIOUR OF *ASPERGILLUS NIGER* NCIM 1245 IN SOLID CULTURES FOR ENZYME PRODUCTION

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Solid state fermentation (SSF) was carried out using different substrates like rice bran and wheat bran for the production of glucoamylase using *Aspergillus niger*. Wheat bran was selected for further studies due to superior enzyme yield. An initial moisture level of 55-60 percent was found to be most suitable for enzyme production. The substrate was enriched with some organic nutrients with a view to increase the enzyme yield. Corn steep liquor, corn steep solid, peptone and soyabean meal were tested at different concentrations (0.5-2.0 percent) along with wheat bran. All of these favourably supported the growth and enzyme producing activity of the microorganisms. The order of effectiveness was peptone > soyabean meal > corn steep liquor > corn steep solid. Enrichment of rice bran by addition of inorganic nitrogen sources viz. ammonium sulphate, ammonium nitrate and ammonium phosphate and organic nutrients like peptone and corn steep liquor resulted in

increased enzyme yield with varying degrees. Scanning electron microscopic observation of fermenting substrate showed good mycelial growth on the substrate and also penetration of mycelia into substrate particles.

BTM-29 CONSTRUCTION OF A LACTATE BIOSENSOR

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A lactate biosensor was constructed that senses L-lactate in the concentration range of 1-1000 µM in solution. The same biosensor also responded to hydrogen peroxide in the same concentration range. Oxidoreducatases or redox enzymes (lactate oxidase) are of particular interest for the construction of amperometric enzyme electrodes, since an electron transfer reaction takes place in the enzymatic conversion of the substrate. A lactate biosensor was constructed by co-immobilizing lactate oxidase and fungal peroxidase in carbon paste electrode. Plain graphite- paraffin oil was prepared by thorough mixing of paraffin oil with graphite powder. Plastic (1ml) syringes were filled with the graphite-paraffin oil paste leaving about 3-4mm empty in the top to be filled with enzyme modified carbon paste to produce the final electrode. The enzyme modified carbon paste was prepared as before by mixing lactate oxidase and fungal peroxidase. The electrode response towards the substrate was checked by flow- injection analysis.

BTM-30 A SIMPLE METHOD FOR REDUCTION OF BIOCHEMICAL OXYGEN DEMAND (BOD) BY RECYCLING OF DIGESTED SLURRY OF FRUIT AND VEGETABLE PROCESSING WASTES OPERATED BIOGAS DIGESTERS

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A technical know-how for biogas production from fruit and vegetable processing wastes was developed in CFTRI, Mysore and the gas was found to be cost competitive to LPG used conventionally as a source of fuel. During the anaerobic digestion, only 50% of organic residues present in the feed were utilised for microbial biomass and biogas production, thus bringing down the biochemical oxygen demand (BOD) from 5000 mg to 400 mg/L. The effluent containing higher BOD beyond 40 mg/L cannot be discharged into the sewerage system as restricted by the State and Central Pollution Control Boards. A simple method was tried by recycling the digested slurry for the preparation of feed for biogas production using semi-continuous mode of operation of the digesters. It was possible to operate digesters for about 9 months, avoiding the discharge of effluent outside without much influence on the rate, yield of biogas, methane and stability of the digesters. Data have

been collected on the operation of digesters with the recycled effluent having mango and orange peel as feed.

BTM-31 ANAEROBIC FIXED FILM REACTOR FOR BIOMETHANATION OF ENSILED MANGO PEEL

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The fixed film reactors offer many advantages over the conventional anaerobic digestion systems used for biogas generation. Since in these conventional processes, the hydraulic retention of the feed is prolonged for more than 25 days, the entire process of treatment becomes uneconomical and unproductive, making the cost of final product methane prohibitory. In this investigation, anaerobic digestion through the fixed film of anaerobes on inert bed of matrices was tried using ensiled mango peel as a substrate for methane generation. The inert solid supports used were treated clay mineral, iron ore and polyvinyl chloride plugs. Various parameters influencing colonisation of anaerobic microorganisms were optimised. The hydraulic retention time (HRT) was reduced to 10 days from 25 days with a considerable increase in the rate and yield of biogas and methane content. .This paper presents the results on the application of different inert matrices for the colonisation of non-methanogens and rate and yield of biogas and methane. The potential advantages of the process are also discussed.

BTM-32 MINERALISATION OF CHLOROBENZOIC ACIDS BY *PSEUDOMONAS AERUGINOSA* 3MT - THE METABOLIC STUDIES

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Chlorinated benzoic acids are introduced into the environment as herbicides and by the incomplete microbial metabolism of polychlorinated biphenyls. Studies on microbial degradation of chlorobenzoic acids are significant from both environmental and academic points of view. *Pseudomonas aeruginosa* 3MT, a natural isolate was able to mineralise 8g/L of 3-chlorobenzoic acid (3CBA) and 12g/L of 4-chlorobenzoic acid (4CBA). Strain 3MT converted 3CBA to 3-chlorocatechol and 4CBA to 4-chlorocatechol, followed by ortho ring cleavage forming chloromuconic acids. This was further degraded through beta-keto adipate pathway. The enzymes (dioxygenases) attacking chlorobenzoic acids were unstable in crude cell extracts. Enhanced dechlorination was observed with permeabilised cells as compared to intact resting cells. The high substrate tolerance and relatively higher chlorocatechol conversion efficiency make strain 3MT a potential candidate for development of a waste water treatment technology.

BTM-33 DEGRADATION OF HEXACHLOROCYCLOHEXANE ISOMERS BY MICROBIAL CONSORTIA

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Very high levels of residues of pesticides such as HCH and DDT have been reported in almost all food articles as well as in human tissues in India and other developing countries. These highly recalcitrant and toxic chemicals find their way into food and then to human body from cultivated soil where they get accumulated. Hence, it is imperative that efficient treatment technologies based on microbial degradation of these compounds in the field have to be developed. In the present paper, development of microbial consortia by various enrichment techniques and degradation of HCH isomers such as alpha-HCH and gamma-HCH in shake flasks are reported. The consortia A-HCH-C developed by a long term enrichment of contaminated soil and sewage samples in a 'semi-continuous column reactor' and then in shake flasks containing alpha-HCH as sole source of carbon and energy were able to degrade upto 25 ppm of alpha-HCH. Presence of acetone (upto 2000 µl/L) as a co-substrate, though not absolutely required for the degradation of alpha-HCH enhanced the biomass build up. Ten ppm and 25 ppm of alpha-HCH disappeared at 5th and 8th day of inoculation, respectively with a concomitant release of Cl^- of about 65% and 56% (on 10th day), respectively. The consortia developed with gamma-HCH as the substrate (G-HCH- S) did not efficiently degrade alpha-HCH, though partial degradation was observed. Acetone, benzoate, glucose, ethanol, cellulose and saw dust were tested as co-substrates; and acetone or benzoate was found to be the best.

BTM-34 DEGRADATION OF CRESOLS BY A STRAIN OF *PSEUDOMONAS* Sp. CP4

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Phenolic compounds including cresols (methylated phenol) constitute a major bulk of environmental pollutants originating from industries such as oil refineries, petrochemical and coal gasification plants, coke ovens etc. These compounds are toxic and recalcitrant and contamination of drinking water with them even in trace amounts renders it unfit for potable purposes. Treatment technologies based on microbial degradation of the toxic constituents of industrial effluents are considered to be very efficient. A strain of *Pseudomonas* sp. CP4 which utilised high concentration of phenol (1.5g/L) has been already reported. The present study deals with the degradation of various levels of different isomers of cresol by this strain. The maximum levels of 0-, m-, and p-isomers of cresols that the strain CP4 can utilise as the sole source of carbon and energy were found to be 14 mM, 10 mM and 20 mM, respectively. However, the rates of degradation of the three

isomers were in the order O- p- m- cresol, the complete disappearance of 5 mM levels of these compounds occurring at 9, 12 and 24 h, respectively. An increased lag phase in growth was observed with increasing concentrations of the compounds. Extracts of cells grown on different isomers of cresols or phenol showed high levels of catechol 2,3-dioxygenase activity, whereas it was not so when grown on glucose or succinate. Catechol 1,2-dioxygenase activity was, either absent or negligible, indicating that the strain followed a meta ring cleavage pathway. The specific activity of catechol 2,3-dioxygenase varied with growth substrates and was in the following order: Phenol>m->o->p-cresol.

BTM-35 **PRESERVATION OF FRESH TOMATOES BY LACTIC FERMENTATION USING *LACTOBACILLUS PLANTARUM***

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Lactic acid bacteria (LAB) play a vital role in natural fermentation and provide a mechanism, wherein vegetables can be stored for extended periods of time without impairing the nutritional qualities. The aim of the study was to preserve the fresh tomatoes by subjecting to lactic fermentation using *Lactobacillus plantarum*, salt and acid tolerant culture. Fermentation characteristics of *La. plantarum* under different salt concentrations in the range of 2 to 4.5% incubation temperatures of 30, 37, 40, 45°C and incubation periods of 0 to 72 h were studied. The starter culture was added at 10% level. The optimum conditions of fermentation were 4 percent salt, incubation temperature of 37-40°C and incubation period of 48 h. The viable lactic count was 2.1×10^{11}, pH 3.5, and acidity 0.9 to 1% and the salt level came down to less than 1 percent in 72 h incubation. Following fermentation, tomatoes were packed with brine in bottles, jars and polyester-aluminium- polypropylene pouches and subjected to pasteurisation at 80°C for 10 min. with immediate cooling. Packed products were stored for 4 to 6 months and the tomatoes were firm and good, indicating the potential of lactic fermentation in the preservation of fresh tomatoes.

BTM-36 **DEGRADATION OF LIMONENE IN ORANGE PEEL OPERATED ANAEROBIC DIGESTION SYSTEM**

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During season, staggering quantities of orange peel become available in the processing plants and their disposal poses a serious pollution problem. Orange peel cannot be utilized for biomethanation process beyond 6 percent loading rate, due to the presence of inhibitory substance, limonene. There is about 3.5 ml of limonene per 100 g of orange peel. A consortium which was

developed, was capable of degrading limonene and biomethanation of orange peel at 8 percent loading rate was achieved with a gas yield of 0.562m^3/kg vs added and 54 percent methane content. The limonene concentration was very low (0.5 ml/100 g) in the effluent and 80 percent of the limonene was degraded. The details of these investigations are presented in this paper.

BTM-37 **SCREENING OF PECTIN HYDROLYZING ANAEROBIC BACTERIAL CULTURES FOR BIOMETHANATION**

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Among the feed stocks employed for methane generation, the agro- industrial and food processing wastes are now recognised all over the world as major non-conventional resources, since the cattle dung and other sources are becoming scarce. Cellulase, hemicellulase, pectin and lignin are the major constituents of fruit and vegetable processing wastes such as mango, citrus, pineapple etc. Pectin is a natural polymer common to the middle lamella and primary cell wall of plants. Pectic substances are not easily biodegradable and thus take longer time for anaerobic digestion. To improve the productivity of the process, efforts were made to develop promising cellulase and hemicellulase producing anaerobic bacteria. Attempts were, therefore, made to develop pectinase, polygalacturonase, pectinlyase and pectinesterase producing anaerobic bacterial cultures by enrichment technique. Removal of pectin by these enzymes would help cellulose and hemicellulose become more accessible to enzymic hydrolysis, thereby increasing the methane yield by several fold. A simple enrichment technique to develop consortia and isolate has been highlighted pure cultures of anaerobic bacteria and screen for pectin hydrolyzing enzymes.

BTM-38 **IMPROVEMENT IN THE RECOVERY OF PINEAPPLE JUICE FROM THE PULP BY USING CELLULOLYTIC AND PECTINOLYTIC ENZYMES**

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Pineapple pulp and its residue after juice extraction were treated with commercial cellulase and pectinase preparations, either singly or in combination to improve juice recovery. With the direct use of enzymes on two successive treatments, the original juice recovered was enhanced by using a combination of cellulase and pectinase. Similar treatments of the pineapple pulp with either pectinase or cellulase singly, increased the juice yield only marginally. On the other hand, treatment of the residue (obtained after initial pressing of the juice from the pineapple pulp), with the enzyme combination of cellulase and pectinase gave increased overall juice recovery compared to direct treatment of the pulp with the enzymes. Changes in the juice viscosity, turbidity, acidity, degree of Brix, etc. on enzyme treatment and the role of pH during enzyme action will be discussed.

BTM-39 CELLULOSE DERIVATIVES FROM WATER HYACINTH

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Materials like cereal straw, bagasse, bamboo, bast fibres etc. are cheap and abundant sources of cellulose. Of the cellulose derivatives, sodium carboxymethyl cellulose has gained major importance both in terms of utilization and production. Attempts were made in the present work to utilize water hyacinth (*Eichornia crassipes*) as a source of cellulose and for derivatization of the isolated cellulose to the ether - sodium carboxymethyl cellulose. Various parameters in the derivatization process viz., the alkalization and etherification parameters were optimized to give Na-CMC of 0.72 DS having a Brookfield viscosity of 40-45 CPU in a 2 percent solution. The prepared CMC was applied to typical food systems like acidified milk beverage and mango-juice, and was found to give good stabilizing and thickening properties.

BTM-40 EVALUATION OF CABBAGE VARIETIES FOR FERMENTATION

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During the peak season, a considerable amount of cabbage is wasted or fed to cattle. It could be perserved by fermentation for consumption during off-season and improve the diet. With this in view, studies were conducted to evaluate cabbage varieties NL-401, NL-501, Alfa Co, Golden Acre, Patti II and Sel 8 for fermentation into sauerkraut. Fresh cabbage was trimmed, cleaned, cored, shredded to 2.5 mm thick shreds, salted at 2.25 percent w/w, filled into jars, covered and pressed with proper weight and allowed to ferment at ambient temperatures (25-30°C). At the end of fermentation, the sauerkraut was pasteurized by heating to an internal temperature of 70°C and preserved using KMS (350 ppm) and sodium benzoate (600 ppm). The pH level of sauerkraut was in the range of 3.5 to 3.1. Maximum acidity was attained in case of NL 401 and NL 501 and sensory evaluation revealed sauerkraut from NL 401, NL 501 and Sel 8 to be the best. Sauerkraut had a shelf-life of more than 6 months at refrigeration temperature and the golden colour was retained better in KMS preserved samples.

BTM-41 BIOCONVERSION OF AROMATIC COMPOUNDS

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Aromatic compounds and their derivatives that originate from various petroleum refineries and other chemical plants contribute a formidable bulk to the chemical pollution of the environment. Microbial degradation of such compounds is believed to be the most efficient way of their elimination. Isolation and identification of bacteria growing on benzene, catechol, naphthalene toluene and sodium benzoate are presented. The cultures isolated are *Pseudomonas pseudoalcaligenes, P. stutzeri, P. doudroffii, P. alcaligenes, Beneckea splendida* 11, *B. pelagia* (biotypes 1 and 11), *Photobacterium angustum*, and *Pleisomonas shigelloides*. The ability of the *Pseudomonas* strains to degrade napthalene and its bioconversion to salicylic acid was studied. The conversion was found to be most effective at 30±1°C, pH-7.2 on gyratory shaker at 120 rpm. The effect of inoculum level, aeration, various nitrogen sources and different carbon concentrations were investigated. These studies showed that, conversion can be successfully modelled by optimising the incubation and media parameters.

BTM-42 Y-LINOLENIC AND ITS PRODUCTION BY *SPIRULINA PLATENSIS*

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Recent pharmaceutical interests and limitations of the sources of Gamma-Linolenic Acid (GLA), a key essential fatty acid has triggered the search for its potential new sources. In this respect, the production of GLA from *Spirulina platensis*-ARM 346 was investigated. The total lipid content of it was 10-14 percent of the cellular dry weight and 20-25 percent of total fatty acids (TFA) and GLA. With increase in illumination from 250 lux to 1200 lux, fatty acid composition was much less affected, but at 1200 lux the percentage of GLA increased. With increase in wavelength from 400 to 700 nm, the percentage GLA of TFA was found to be highest in orange spectrum of light (26.53 percent). By changing the growth temperature from 20°C to 40°C, the percentage of GLA decreased and was highest at 20°C (25.53 percent). Degree of saturation increased with temperature. Among the various nitrogen sources, urea (0.01M) was found to be the most effective, resulting in 24.89 percent of GLA. The optimum concentration of NaCl, $CaCl_2$ and $MgSO_4$ for maximum GLA synthesis were 0.034 M, 0.0004 M and 0.0008 M, respectively. Silver complex, urea adduction and winterisation were used for purification of GLA. Urea adduction was found to be the most adequate. At the third cycle of purification, it concentrated GLA to 80 percent. GLA was the main fatty acid in

the lipids of thylakoid membranes (TM) in *Spirulina* spp. Ultrastructure of the cells grown under optimum conditions revealed high contents of TM stackings.

BTM-43 PHYSICO-CHEMICAL PROPERTIES OF ENTEROTOXIN PRODUCED BY *BACILLUS CEREUS* ISOLATED FROM MEAT PRODUCTS

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An enterotoxin produced by *Bacillus cereus*, isolated from a pork product was purified. Its molecular weight was 60,000. The enterotoxin caused fluid accumulation in the ligated ileal loop of rabbit. It was neither lethal to mice nor did it cross-react with the antiserum raised against enterotoxin of *Staphylococcus aureus* and *Clostridium perfringens* type A. The vascular permeability reaction (VPR) was sensitive to heat at 45°C for 30 min., proteolytic enzymes (pepsin and trypsin) and extremes of pH (< 6.0 and > 8.0), but resistant to EDTA. The hemolysin was destroyed by heat at 45°C for 10 min., proteolytic enzymes and alkaline pH (>8.0). However, the phospholipase activity of the enterotoxin was resistant to heat at 100°C for 15 min., proteolytic enzymes and wide variations in the pH (2.0 to 11.0).

BTM-44 STRUCTURAL ANALYSIS OF MICROBIAL EXOPOLYSACCHARIDES BY SOLID STATE C-13 NMR

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Microbial exopolysaccharides are looked at more and more by the food industry as an alternative to the traditional plant and animal gums for their better gelling and viscosity increasing effect in various aqueous food formulations. Industry can depend more on microbial gums, because it eliminates dependence upon uncertain raw materials. Attempts made in this direction led to the purification and structural analysis of polysaccharides PS I and PS II secreted by an *Alcaligenes* species PSO 13 and PS III secreted by an *Agrobacterium* species PSO 11, both of which are natural isolates. Purification was achieved by alcohol precipitation, followed by ion-exchange chromatography. The homogeneous polysaccharides were subjected to solid state C-13 NMR. The spectra for PS II showed it to be a 1-3, B-D-Glucan. The presence of succinic and pyruvic acid substitute groups were observed for PS I and PS III. PS I and PS III were found to be complex

polysaccharides with 1-3, 1-4, 1-6 linkages of B-type. Preliminary inferences drawn from NMR spectra are being ascertained by chemical analysis.

BTM-45 PRODUCTION OF XYLANOLYTIC ENZYMES BY ANAEROBIC BACTERIA

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Biomass from plant sources is the largest resource available all over the world to be utilised for food, feed, fuel and fine chemical production by microorganisms. Cellulose and hemicellulose constitute the major components of these plant materials. Since these polymeric constituents are recalcitrant to biodegradation, attempts were being made to pre-treat the biomass with enzymes such as cellulases and hemicellulases produced by aerobic and anaerobic fungal and bacterial cultures in order to make the process economical. Samples from different habitats were collected and 31 consortia were developed by selective enrichment technique. Some pure cultures of anaerobic bacteria were also isolated from the promising consortia. Selected consortia and pure cultures were cultivated in a simple defined medium containing 4 percent (D.W.) of xylan prepared from corn cob. Extracellularly xylanase, endo-glucanase, exoglucanase, beta-glucosidase under static fermentation conditions were assayed by the standard methods. Some of the pure and mixed cultures of anaerobes exhibited activities as high as 374 n katals xylanes. This paper reports a simple method of isolation of anaerobic cultures/consortia for xylanase production using enrichment technique.

BTM-46 ENSILAGING OF PRAWN CARAPACE BY LACTIC FERMENTATION

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Studies were conducted to standardize a process for the preparation of an ensilage of prawn carapace by lactic fermentation. Pre-treatment of the raw material, the level of molasses as the fermentation substrate, and the type of starter culture were the variables studied. Pre-treatment of raw material comprised mincing, separation of shell fraction and initial acidification. Molasses was used at 10, 15 and 20 percent levels. Sauerkraut and pre-fermented pulp were used as starter cultures. Fermentation was assessed by changes in pH, total plate count and counts of lactic acid bacteria. Spoilage was noted by development of off-odour and worm infestation. It was observed that, prawn carapace had to be minced, the chitinous carapace matter removed and the residual pulp acidified by addition of 1.5 to 2 percent acetic acid to a pH below 6.0. This pulp was mixed with 15 percent molasses and backslopped with 24 h pre-fermented pulp. Fermentation for 48 h brought

down the pH to below 4.5. The ensilage could then be stored for over 2 months with 0.1 percent sorbic acid as preservative.

BTM-47 IMPROVEMENT OF PADDY ARRACK - A TRADITIONAL FERMENTED BEVERAGE

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As the traditional fermentation of paddy arrack using paddy husk as source of inoculum in paddy malt (25 percent equivalent to 18.1 percent dextrose) mash yielded very low levels of ethanol (4 25 percent v/v), cultural and nutritional conditions were optimised to obtain improved yields of ethanol. Of several isolates of yeast made from paddy husk, an isolate PHO3 was found to be better than others in improving the ethanol yield. Use of *Zymomonas. mobilis* ZM4 as co-culture in fermentation gave synergistically more ethanol (10.1 percent v/v), than the use of single cultures. About 98.5 percent of the carbohydrate was accountable in the fermentation yielding 86.7 percent of the theoretical yield of ethanol. Addition of yeast extract and the hydrolytic enzymes (alpha-amylase, glucoamylase and papain) further improved not only the ethanol yield (11.2 percent, v/v), but also reduced the fermentation time by 24 h. The improved product tasted better than the traditional one. Thus, the traditional fermentation of paddy arrack from paddy malt could be improved to a great extent.

BTM-48 POTENTIAL OF WINE PRODUCTION FROM ORANGES

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Nagpur Santra (*Citrus reticulata*, Blanco) is a variety of mandarin cultivated widely in Nagpur which has an excellent taste and aroma. Juice extracted from the fruits procured from local market was subjected to alcoholic fermentation using a culture of wine yeast viz., *Saccharomyces cerevisiae* var. *ellipsoideus* for 5-7 days at 37°C. The alcohol content of wine was 9-12 percent, with a low level of tannins. Use of pectic enzyme resulted in a clear product. The study indicated the potential use of orange fruit of Nagpur Santra variety in making an acceptable quality wine.

BTM-49 INHIBITION OF SPOILAGE AND PATHOGENIC MICROFLORA OF DRESSED CHICKEN BY LACTIC CULTURES

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Studies were conducted to observe the possible role of some lactic cultures like *Lactobacillus acidophilus*, *Streptococcus lactis* and *Pediococcus cerevisiae* in inhibiting the inherent spoilage and pathogenic microflora of chicken carcasses during refrigerated storage. The lactic cultures were separately grown in specific enrichment broths and were sprayed on dressed chicken along with cells or as cell-free extracts. The treated carcasses were packed individually in LDPE bags and stored at $5\pm1^{\circ}C$. They were microbiologically analysed at 24 h intervals for the respective lactic cultures and other microbes such as total aerobes, coliforms, *Staphylococcus aureus*, yeast and molds, and proteolytes, till the off-odour developed. The results indicated a definite decrease in the multiplication of spoilage and pathogenic microflora on treated chicken carcasses, as compared to the untreated control. However, none of the treatments could substantially decrease the overall counts to achieve any significant increase in the shelf-life of treated samples over control. Further, experiments were also carried out by dipping the dressed chickens in cell-free extract of lactic cultures instead of spraying, without any further improvement in storage stability.

BTM-50 DECONTAMINATION OF PESTICIDE RESIDUES USING B-CYCLODEXTRIN

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Pesticide residues are encountered on agricultural produce due to frequent and indiscriminate application of pesticides. Organochlorine residues in the range of 2-6 ppm and organophosphates in the range of 1-2 ppm have been reported to be present on fruits and vegetables. The common domestic practice of cleaning and washing fails to remove pesticide residues completely. B-cyclodextrin (cycloheptaamylose) has been known to form inclusion complexes with some pesticides. An attempt has been made to use B-cyclodextrin as a decontaminating agent. A mixture of B-cyclodextrin and sodium acetate dissolved in water could dislodge residues of commonly used pesticides like DDT, HCH, malathion, fenitrothion, thiram and cypermethrin on various fruits and vegetables. Fruits and vegetables fortified with the above pesticides upto 10 ppm levels could be brought down to 0-2 ppm in most cases. The above process was carried out in 500 g lots of fruits and vegetables.

BTM-51 INFLUENCE OF CHEMICAL FACTORS ON ALPHA-GALACTOSIDASE PRODUCTION BY *ASPERGILLUS NIGER* MRSS 234 IN SOLID STATE FERMENTATION SYSTEM: A STATISTICAL APPROACH

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Effect of a total of five chemical factors, selected earlier by Plackett-Burman design and include nitrogen sources, enzyme inducers and growth as well as enzyme promoters, on the production of alpha-galactosidase by *Aspergillus niger* MRSS 234 in solid state fermentation system was evaluated. Statistical method used was the central composite rotable design under response surface methodology and the search of the optimum set by flexible polyhedron search method. A number of optimum sets were tested by further experimentation. The best optimum set, which gave 70.7 percent greater enzyme titres, as compared to the control medium, contained 10 g sieved wheat bran (SWB) and (percent, w/w) urea 3.5, corn steep liquor 10.0, guar flour 19.5, soy flour 20.0 and citric acid 0.5. The economic optimum set consisting of 10 g SWB and (percentage, w/w) urea 2.75 corn steep liquor 3.0, guar flour 7.5, soy flour 0.2 and citric acid 0.2 gave 42.6 percent greater enzyme production.

BTM-52 ANAEROBIC DEGRADATION OF CELLULOSE BY ANAEROBIC BACTERIA AND THEIR CONSORTIA FOR METHANE GENERATION

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Besides fossil fuels, biomass is the largest energy source available all over the world. If it is anaerobically digested, methane produced can be used as an energy source and the digested slurry would find application as a manure. In order to improve the biodegradation of cellulose, present in the food processing and agro-industrial wastes for biogas generation, studies were made to develop 36 consortia from the starter cultures collected from different habitats using enrichment and baiting techniques. The consortia represented by anaerobic bacteria were able to degrade filter paper cellulose efficiently and their maximum endo-B-1,4-glucanase, exo-B-1,4-glucanase and B-glucosidase activities obtained were 1.7, 0.5 and 4.5 IU/ml, respectively. Addition and maintenance of selected consortia in the digester for methane generation resulted in 50 percent more degradation of cellulose, as compared to control. The consortia exhibiting maximum enzyme activities were inoculated in the previously stabilized conventional type biogas digesters and the rate and yield of biogas and methane were recorded periodically. The maximum yield of biogas with addition of consortia was 0.4 m^3/kg volatile solids added, whereas the control digester yielded 0.38 m^3/kg volatile solids added in control digester. The methane content was 50 percent with a consortium developed from the compost sample collected locally, whereas that of control was 45 to

47 percent. An increase of 5 percent over the control was achieved with a consortium predominated by the clostridial cultures.

BTM-53 **PLANTS AS A POTENTIAL SOURCE OF ANTAGONISTIC LACTIC ACID BACTERIA**

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Plants are known to harbour lactic acid bacteria (LAB). Studies were carried out to isolate the antagonistic LAB from plant sources for their potential application in preservation of vegetables and their products. Leaves, buds and flowers of 31 plants belonging to 17 genera collected in two vegetable farms at Mysore were screened for the occurrence of LAB. Species of *Lactobacilli* and *Lactococci* were predominant in the following plant genera: *Acanthus*, *Moringa*, *Raphinus*, *Phaseolus* and *Hibiscus*. Of the 88 LAB isolates, 74 percent were homofermentative and 88.5 percent of them grew in a pH range of 4 to 5 in 24 h at 37°C. LAB isolates were screened for potential antimicrobial activity. Cell-free culture filtrates (CCF), culture filtrates heated at 80°C for 30 min. (HCF) and culture filtrates neutralised to pH 6.8 (NCF) were tested for the inhibitory effect against *Bacillus macerans* and *Pseudomonas* spp. by agar well diffusion assay. The three types of filtrates (CCF, HCF and NCF) showed inhibition of 87, 83 and 2.5 percent, respectively, against *B.macerans*, while the corresponding values were 31, 74 and 7.6 percent, respectively against *Pseudomonas* spp. Antagonistic isolates of LAB (11 nos) which showed strong degree of inhibition, on further screening, showed the inhibitory effect against *B. macerans B. licheniformis B. coagulans* and *Enterobactor*, while *Staphylococcus aureus* was not inhibited.

BTM-54 **UTILISATION OF STILLAGE AS WHEAT BRAN MOISTENING AGENT IN SOLID STATE FERMENTATION FOR PRODUCTION OF AMYLOGLUCOSIDASE BY *ASPERGILLUS NIGER* 1105**

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Stillage, a distillery liquid effluent, needs extensive treatment as otherwise it causes severe pollution due to high BOD load. In order to reduce the volume of effluent to be subjected to cost-intensive waste treatment methods, preliminary studies were carried out on its efficiency for use as moistening agent in production of amyloglucosidase by *Aspergillus niger* 1105 in solid state fermentation system. When stillage as such was used, the enzyme production was reduced by 40.39 percent. Dilution of stillage with water indicated that the reduction was 14.09 percent, with the use of 1:4 ratio of stillage to water. Demineralisation of stillage with 5 and 20 percent, each of cationic

and anionic resin (26.0 and 68.3 percent ash removed) allowed the use of 1:3 and 1:0.5 ratios with 9.3 percent and nil reductions in enzyme production, respectively. Stillage demineralisation with 20 percent resins allowed the complete replacement of conventional moistening agent with stillage, but at a cost of 14.35 percent lower enzyme production.

BTM-55 **FERMENTATIVE PRODUCTION OF L-GLUTAMINASE BY MARINE *PSEUDOMONOAS FLUORESCENS* A C M R 171**

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The commercial importance of L-glutaminase (L-glutamine aminohydrolase EC 3.5.1.2) is well established in food industry and in pharmaceuticals and there is a need to explore the availability of potential sources. An attempt was made to assess the production of L-glutaminase by *Pseudomonas fluorescens* of marine origin under submerged fermentation. The results indicated that, this bacterial strain elaborated significant titres of glutaminase in basal synthetic medium over a wide range of operational parameters such as pH 5-8, temperature 25-45°C, NaCl concentration of 0-5 percent, substrate concentration of 0.5-3.0 percent within 18-24 h of incubation. Glucose at 0.5 percent level was observed to enhance the enzyme production to a considerable extent. The study highlighted the suitability of marine bacteria as potential sources of glutaminase.

BTM-56 **EFFICACIES OF CONIDIAL INOCULUM DEVELOPMENT AGAR MEDIA AND OPTIMIZATION OF THE EFFICIENT MEDIUM ON PROMOTION OF PROTEINASE PRODUCTION IN MOIST WHEAT BRAN MEDIUM**

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Five different conventionally used conidial inoculum development agar media were evaluated for efficacy in promoting proteinase production in moist wheat bran medium by *Aspergillus oryzae* CFTRI 1480 in solid state fermentation system. Czapek's agar promoted highest enzyme production and hence was selected. Its enrichment separately with corn starch, casein, tryptone, yeast extract, malt extract and peptone, each at 0.5 percent concentration (w/v), showed 7 percent increase in enzyme titres with the use of 0.5 percent peptone. Mere increase in peptone to 0.75 percent reduced the enzyme production by 16 percent. Further enrichment of 0.5 percent peptone containing Czapek's medium with other protein and growth promoting biologically complex compounds as well

as corn starch, significantly reduced the enzyme production. The use of the optimized conidial inoculum development agar medium (9.6 x 10^8 conidia/10 g, wheat bran) promoted 11 percent increase in proteinase production as compared to potato dextrose agar medium used earlier. The data indicate the importance of standardizing inoculum development medium.

BTM-57 POST-HARVEST PATHOGENESIS OF GUAVA (*PSIDIUM GUAJAVA* L.)

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Pectinolytic and cellulolytic enzymes produced by fungal pathogens have been widely studied in relation to post-harvest diseases of fruits and vegetables. In post-harvest spoilage, involvement of pectinolytic enzymes in fruit pathogenesis has been correlated with tissue maceration. *Aspergillus niger* van Tiegh isolated from guava (*Psidium guajava* L.) was found to be responsible for post-harvest spoilage of fruit. Pathogenesis of the fungus in the post-harvest spoilage of different cultivars of guava has been substantiated by Koch's studies. Pectinolytic enzyme complex produced by *A. niger* was further studied to know the proportionate contribution of individual components viz., Polygalacturonase (PG, EC 3.2.1.15), Pectinesterase (PE, EC 3.1.1.1.11) and pectin lyase (PL, EC 4.2.2.10). Pre-inoculation studies revealed that this composite enzyme system was primarily responsible for induction of soft rot in certain unconventional fruits like ber (*Ziziphus mauritina* L.) and ramphal (*Annona reticulata* L.). Softening of such fruits was attributed to the dissolution of cell wall component, mainly pectin by pectinolytic enzyme.

BTM-58 EFFECT OF ADDITIVES ON TEXTURAL PROPERTIES OF INSTANT *DOSA*

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In the present study, to improve the textural quality, gas holding capacity and overall acceptability of instant *Dosa* different polysaccharides were tried i.e.microbial (Xanthan), plant (guar gum) and modified plant gum (carboxy-methyl- cellulose), as such and in combination. Textural studies were performed using Instron at chart speed of 100mm/min., for the softness in freshly prepared product and after 7 h of storage. Effect of additives on rheology and gas holding capacity of *Dosa* batter were determined by Rheotest. Consistency index with microbial additives showed better *Dosa* at 0.1 percent level, than plant and modified sources where it was obtained at higher levels (0.2-0.3 percent). Overall keeping quality was better with microbial additive, than other

additives and control. Amylographic pattern was assessed for degree and time of gelatinization with and without additives.

BTM-59 **TECHNO-ECONOMIC FEASIBILITY STUDY OF MANGO PROCESSING WASTES FOR METHANE GENERATION**

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In order to develop the technical know-how, large scale trials in 25 m^3 KVIC digesters were carried out based on laboratory and bench scale studies for biogas generation from dried mango peel. Environmental and nutritional parameters, such as organic loading rate, hydraulic retention time, composition of feed stock, supplementation of nutrients, pH, volatile fatty acid concentrations, alkalinity and total biodegradability were optimised for the maximum production of biogas. A maximum yield of 0.6 m^3/kg VS added with 52 percent methane content at the rate of $2m^3/1m^3/d^{-1}$ was obtained and its cost of production was compared with the liquid petroleum gas (LPG) which cost Rs. 97/- and Rs. 323/- for domestic and commercial cylinders, respectively. The cost benefit ratio has been calculated for Techno-economic feasibility report.

BTM-60 **INFLUENCE OF ADDITIVES ON BIOGAS PRODUCTION FROM MANGO PEEL**

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The conventional process of biogas production from agro- industrial wastes and biomass is considered to be unproductive and uneconomical due to poor biodegradation of organic residues in a continuous or semi-continuous anaerobic digesters. Different additives and stimulants were tried to enhance the yield of biogas and also improve the productivity of the process. Surfactants are known to agglomerate the microbial cells enabling good floc formation and therefore, the effects of the extracts of natural plant sources containing surfactants and related materials and their different concentrations and combinations on biogas and methane production were studied. Supplementation of guar gum seeds at the rate of 2.5 to 3 percent in the feed enhanced 1.6 times higher biogas than the control. The paper presents data on the effect of surfactants on the rate and yield of biogas from mango peel.

BTM-61 STUDIES IN FERMENTATIVE PRODUCTION OF CITRIC ACID USING NOVEL YEAST-BASED PROCESS

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Citric acid is one of the most important organic acids in terms of bulk production. It is estimated that some 400,000 tons/year are now produced largely by process involving *Aspergillus niger* using sugary substrates, mostly beet or cane molasses. The process using *A. niger* is under critical control of process parameters such as pH, temperature, metal ion concentration etc. and has long process time. It is reported that increasing amounts of citric acid are being produced using yeast mainly *Yarrowia lipolytica* using hydrocarbon as substrate, but reports are controversial. In view of the possible presence of carcinogens in hydrocarbon, other constraints and difficulties in *A. niger* process, it was felt necessary to develop an alternative process. In the present work, attempts were made to develop a process for production of citric acid using suitable yeast species utilizing sucrose as substrate. Primary screening resulted in selection of *Candida guilliermondii* as a potent culture capable of growing on sucrose with promising yields of citric acid. Nutritional as well as biochemical characteristics of the culture were established.

BTM-62 EFFECT OF HYDROQUINONE ON THE GROWTH OF *METHANOSARCINA* Sp

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Quinones play an important role in the metabolism of proteins, carbohydrates and fats through their participation in electron transport system. Their influence in the physiology and biochemistry of methanogens, a group of archaebacteria that differ from eubacteria and eukaryotes has not been studied. Therefore, the effect of different concentration of hydroquinone and its combination with varying levels of acetate as carbon source on *Methanosarcina* sp., a predominant organism encountered in the fruit and vegetable processing wastes-fed digester was studied. Lower concentration of hydroquinone in the defined medium stimulated maximum specific growth and methane production, whereas higher concentrations were found to be inhibitory.

BTM-63 SHORT CHAIN FATTY ACID ESTER SYNTHESIS BY LIPASE

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Short chain fatty esters play an extremely important role in the field of aroma compounds. Studies were carried out using lipase from *Mucor miehei* in synthesising these short chain fatty acid esters. Esterification kinetics and equilibrium studies of acetic acid with butanol and isomyl alcohol were carried out for obtaining maximum yields. Various parameters like temperature, effect of organic solvents, effect of substrate and water concentration and reusability of enzyme were studied. The presence of organic solvents like hexane, heptane at 60°C increased the yield of esters. The enzyme had substantial activity for 5 cycles. The results revealed that yield for isoamyl acetate was better as compared to butylacetate.

BTM-64 EFFECT OF CULTURE CONDITIONS ON MONASCUS PIGMENTS

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Colorants from microbial species offer considerable advantages since they can be produced in any quantity and are not subjected to the vagaries of nature. *Monascus purpureus*, a fungus long used in the production of Chinese food-"angkhak" or red rice, produces red (Rubropunctatin and Monascorubin) and yellow (Monascin and Ankaflavin) pigments, has a promising application in food system. Studies on optimization of culture conditions for maximum pigment synthesis were carried out. The parameters studied were pH of the medium, time and temperature of incubation, inoculum size and different carbon sources. The results showed that, the pigment synthesis can be successfully modelled by optimising the culture conditions.

BTM-65 A COMPARATIVE STUDY OF *CHHANG* FERMENTATION OF RAGI USING NATURAL (TRADITIONAL) AND PURE MICROBIAL INOCULA

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Chhang is a traditional fermented beverage from ragi or barley which is consumed by the population in the sub-Himalayan region and other Tibetian settlements. The beverage is prepared traditionally with undefined inoculum (*Phab*) under unhygienic and uncontrolled conditions, many a

times resulting in inconsistent quality of the product. Well characterised starter cultures (*Endomycopsis fibuligera*, *Saccharomyces cerevisiae* and *Leuconostoc dextranicum*) isolated from the traditional inoculum *phab* were used in the fermentation and compared with that of *phab* as such, using not only ragi, malted ragi but also their grits. There was better starch conversion efficiency from 20 to 40 percent in case of 20 percent grits medium, than that in whole grain solid state fermentation. Temperature of 20°C, pH 6.5 (natural) and incubation period of 6 days were found to be optimum for the fermentation. Malted grits mashed medium further improved the starch conversion efficiency by 50 percent with these inocula, and also imparted better flavour and aroma to the product. Consistency in quality of *chhang* in terms of ethanol (2.5 to 3.0 percent, v/v), total acidity (0.4 to 0.6 percent) volatile acidity (0.03 to 0.06 percent) and pH (3.8 to 4.1) was obtained in case of pure cultures as compared to inconsistency of the product in case of *phab*.

BTM-66 **SCREENING OF FUNGAL CULTURES FOR PRODUCTION OF EXTRACELLULAR NUCLEASE**

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Nuclease enzymes find a number of potential industrial applications such as reduction in nucleic acid content of single cell protein (SCP), production of flavour nucleotides by RNA hydrolysis. Fungal (138) belonging to isolates a wide variety of genera, isolated in the laboratory or procured from various culture collections, were screened for extracellular nuclease production. Out of them, 25 were found to produce large amounts of potent RNAase in glucose-peptone mineral medium which degraded RNA to form 3' nucleotides. None of the RNAases produced by the screened cultures, however, yielded 5'nucleotides. This points to the fact that 3'nucleases are more predominant in nature, than 5' nucleases.

BTM-67 **BIOTRANSFORMATION OF CAPSAICINOID INTERMEDIATE TO CAPSAICIN AND VANILLIN IN IMMOBILIZED CELL CULTURES OF *CAPSICUM FRUTESCENS***

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Capsaicin is an important food additive and also a pharmaceutically important compound. Vanillin is a flavouring agent whose usage is found in flavour industries. The production of these

compounds by biotransformation of precursors in immobilized cells of *Capsicum frutescens* may become a useful process. Additives such as ferulic acid, vanillylamine, protocatechuic aldehyde and caffeic acid at 2.5 mM each were biotransformed to vanillin and capsaicin. The maximum amount of capsaicin was obtained in immobilized cells fed with 2.5 mM vanillylamine with a production of 190 μg/g cells in 6 days of culture period, whereas ferulic acid fed cells produced 104.25 μg/g cells on 9th day. Ferulic acid fed cultures produced maximum vanillin on 15th day of culture with a production of 315.5 μg/g cells, whereas vanillylamine produced 253.75 μg/g cells on 6th day. Protocatechuic aldehyde and caffeic acid were not effective in these biotransformations.

BTM-68 METHOD TO CONTROL POLLUTION BY PADDY SOAK WATER

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Paddy soak water effluent discharged from rice mills has become a cause of environmental pollution. The paddy soak water is turbid yellow in colour and contains about 7.64, 690 and 55 mg/l dissolved solids, chlorides and phenols, respectively and has 1480 mg/l BOD and 2200 mg/l COD with foul smell. Filtration of soak water through paddy husk black ash column of 2.5 m height improved the quality of water. The turbidity was removed and the yellow colour was completely bleached to a clear light white colour. The dissolved solids, chlorides and phenol contents were reduced to 1.4, 140 and 3 mg/l, respectively. The pH increased from 5.5 to 8.0. However, the BOD and COD were not much reduced. The fungi and bacterial load decreased from 7.9×10^2 and 21.5×10^6 to 6.3×10^2 and 13.0×10^6/ml.

BTM-69 INCIDENCE OF PATHOGENES IN READY-TO-EAT STREET FOODS OF MYSORE CITY

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The microbiological quality of ready-to-eat street foods served in Mysore city (Karnataka) was determined during a survey of 231 samples drawn from nine categories of food items namely, non-alcoholic beverages, salads, dairy products, sugar-based sweets, bakery products, deep-fried products, non-vegetarian dishes, cereal/pulse-based products and *pan bheedas*. During the course of this study, the qualitative/quantitative presence of the following five commonly occurring pathogens namely, *Escherichia coli*, *Staphylococcus aureus*, *Bacillus cereus*, *Salmonella* spp. and *Shigella* spp. were specifically determined. The study revealed that freshly cooked and served hot foods (of any kind) were free from the pathogens studied, except for *staphylococci* in few cases. A close examination of the frequency of occurrence of the above pathogens in various foods brought out the

following significant observations. *Staphylococcus* spp. was observed in 54 percent of almost all categories of foods analysed. *E. coli* and *B. cereus* were encountered in 30 and 15 percent of the samples analysed respectively. *Salmonella* and *Shigella* were found in less than 1 percent of the samples analysed.

BTM-70 **EFFECT OF VARIOUS DISINFECTANTS ON THE VIABILITY OF *VIBRIO CHOLERAE* 01 IN ARTIFICIALLY CONTAMINATED SHELL ON SHRIMPS**

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The increasing reports on seafood-associated outbreaks of *Vibrio cholerae* 01 have necessitated the need to reassess the effect of various disinfectants. The inhibitory influence of four different disinfective agents *in vitro* was evaluated to efface *V. Cholerae* 01 in shell-on shrimps after artificial contamination. Survival of the test organism was not observed either by direct or enrichment plating from 3 and 4 ppm of benzalkonium chloride and hypochlorous acid (HOCl), respectively after 10 min. of exposure. In contrast, sodium citrate at 5,000 ppm and calcium tartrate at 50 ppm were found to have no bactericidal effect, even after 60 min. at all the maximal concentrations. Disinfection studies employing shell-on shrimps after artificial contamination with *V.cholerae* 01 showed that benzalkonium chloride was less effective at a test concentration of 15 ppm after exposure time of 60 min. However, 5 and 10 ppm hypochlorous acid was found to be more effective and identical, since no *V.cholerae* 01 was dected after 20 min. either by direct or enrichment plating. These studies demonstrate that, hypochlorous acid at a concentration of 5 ppm for 30 min. exposure at ambient temperature was adequate to inactivate *V.cholerae* 01 in shell-on shrimps.

BTM-71 **RAPID SCREENING OF VARIOUS NUTRIENTS FOR THE FERMENTATIVE PRODUCTION OF 2-HEPTANONE BY *TRICHODERMA HARZIANUM* (T): A STATISTICAL APPROACH**

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Fermentative production of metabolite is known to have complex nutritional requirements, in the form of various carbon sources, organic and inorganic sources of nitrogen and trace elements. A total of 35 nutrients from these classes were screened for the production of 2-heptanone. The relative importance of each one of these nutrients was assessed using Plackett-Burman design. The rapid screening procedure indicated that the first five components showing most positive effects were $MnSO_4$, H_3BO_3, $CaCl_2$, NH_4Cl and $MgSO_4$. The other components showing most negative effect were sodium octanoate, peptone, KH_2PO_4, KI and Xylose. None of the sugars/nitrogen sources showed positive or high negative effects. The total experimental effort was reduced as the effect of

large number of variables were simultaneously assessed instead of studying a single variable at a time. The highest yield of heptanone obtained was of the order of 510 ppm and further screening for improvised yields is in progress.

BTM-72 STUDIES ON COMMERCIAL DOMESTIC WATER FILTERS AND LOW COST SAND-CHARCOAL FILTER

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Turbidity, pesticide residues and high counts of bacteria render water unacceptable for potable use. An evaluation of point-of- use systems covered commercial units of domestic candle filters and iodophor-coated resin filters as well as fabricated sand charcoal filters. Of 20 domestic candle filters tested for bacterial parameters including coliforms, 12 units were positive for coliforms although turbidity was acceptable. Resin-filters containing iodophor were partially satisfactory for bacteriological quality, but failed on account of turbidity. Both types were ineffective in treating pesticides. Sand- charcoal filters were very cheap to fabricate and removed sevin and lindane spiked at levels of 0.2 and 5 mg/L for 30 and 150 litres of water, respectively. Further, sand-charcoal filters satisfied requirements on turbidity. However, filtered water contained counts of bacteria higher than in untreated water. A supplementary treatment using solar disinfection satisfied microbiological quality of filtered water for potable use. On exposure to 6 h in sunlight, approximately 10 million cells of indicator bacteria like *B.cereus*, *S.aureus*, *E.coli*, *Pseudomonas* sp. and *Salmonella madrasensis* inoculated into water were reduced to less than 1 per litre of water.

BTM-73 DEVELOPMENT OF A PROTOTYPE FOR TREATMENT OF WATER USING SAND-CHARCOAL FILTER EXPOSED TO SUNLIGHT AS COMPARED TO COMMERCIAL UV-TREATMENT DEVICE

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Six units of a commercial brand of treatment device based on ultraviolet disinfection gave *E.coli* free water upon treatment. However, coliforms were present in 3 units and 2 units gave aerobic plate count in excess of 50/ml. Bacteriological build-up accounted for increase of indicator bacteria

in the filtered water from sand-charcoal filters contained in opaque plastic material or when operated away from exposure to direct sunlight. Bactericidal action on fouled filters varied with different chemicals such as a quaternary ammonium compound, Tween-80, sodium hypochlorite and hydrogen peroxide. Exposure of the filters in glass column to direct sunlight, disinfected the filters and the treated water had acceptable bacteriological quality. Water stored in vessels made up of glass or plastic was superior to metals like aluminium, copper, mild steel and stainless steel in terms of bacteriological quality. Of 5 types of packing materials used as cover against aerosol contamination of stored water, low density polyethylene (LPDE) was found acceptable. The effective prototype treatment made use of sunlight during filtration through sand-charcoal filter in transparent glass column and exposure of filtered water to direct sunlight protected from dust.

BTM-74 **CATABOLITE REPRESSION BY GLUCOSE ON THE BIOSYNTHESIS OF ALPHA AMYLASE IN SUBMERGED AND SOLID STATE FERMENTATION BY *ASPERGILLUS NIGER***

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Catabolite repression on the synthesis of enzymes is commonly encountered in microorganisms. Repression on the synthesis of alpha amylase by glucose was reported in bacteria and fungi under submerged fermentation. However, information on catabolite repression in solid state fermentation (SSF) is scanty. In the present study, attempts were made to find out the effect of glucose on the synthesis of alpha-amylase under submerged and solid state fermentation employing *Aspergillus niger* CFTRI 1105. On a comparative basis, the production of alpha-amylase was recorded higher in solid state fermentation, than in submerged fermentation. Addition of glucose (in soluble form before inoculation) did not enhance the production of alpha- amylase in both the cases. However, a drastic decrease in alpha- amylase production was observed in submerged fermentation by the addition of 0.5 percent glucose, whereas 10 percent glucose concentration completely suppressed alpha-amylase production. In case of SSF, the repression was negligible, even when glucose level was raised to 10 percent.

BTM-75 **PROFILE OF PYRETHRINS DERIVED FROM LEAF CALLUS OF *CHRYSANTHEMUM CINERARIAEFOLIUM*: A GC-MS STUDY**

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Production of biopesticide pyrethrins from *in vitro* culture of *Chrysanthemum cinerariaefolium* is considered as viable alternative method for production from field grown plant material. However, pyrethrins derived from *in vitro* method should have comparable bioefficacy to the natural ones. The

bioefficacy is attributed to the ratio of constituent esters of pyrethrins present in the sample and also the total content. A comparison of pyrethrins from callus and samples obtained from floral extract was made by GC-MS studies. The extract was prepared by grinding the tissue or by dissolving the sample in petroleum ether (40-60). It was found that ECD., FID & MS spectra showed the presence of Pyrethrins I constituting Pyrethrin I, Cinerin I and Jasmolin I; Pyrethrins II constituting Pryethrin II, Cinerin II and Jasmolin II. It was found that Jasmolin II was in both callus and flower derived pyrethrin extracts. The percentage of pryethrins I in total pyrethrins in callus and floral derived pyrethrin as measured by FID was 31.49 and 30.90, respectively and 85.84 and 87.3 by GC-MS spectral data. FID & GC-MS showed that pyrethrins of callus extract compared with that of flower derived ones.

BTM-76 A STUDY ON PRODUCTION OF AMYLASE BY SOLID STATE FERMENTATION

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An attempt was made to develop a cheap medium based on indigenous crops for the production of fungal amylase by solid state fermentation. Amongst the various amylase producing strains of *Aspergillus*, *A. oryzae 553* was found to be suitable for enzyme production by SSF. Use of starchy substrates such as jowar and bajra gave higher yield. The lumping of jowar could be avoided by incorporating jowar stalk (*Kadbi*) at 30 percent level. Maximum enzyme production (225 U/g) was observed at C/N ratio 10-12. Dried moldy substrate could be stored for 60 days without appreciable loss of enzyme activity. The kinetic parameters of enzyme were also investigated.

BTM-77 OPTIMIZATION OF TANNIN ACYL HYDROLASE PRODUCTION BY *ASPERGILLUS NIGER* PKL 104 IN SOLID STATE FERMENTATION USING RESPONSE SURFACE METHODOLOGY

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Optimization of five physical parameters, viz., initial moisture, inoculum ratio, initial pH, incubation temperature and fermentation time for tannase production in solid state fermentation was carried out using the central composite rotable design falling under response surface methodology. The analysis of the data by the flexible polyhedron search showed that the enzyme production was affected by all the five parameters. Initial pH exhibited a positive interaction with moisture, but no interaction with other parameters. Initial moisture and inoculum ratio showed a negative interaction in contrast to the positive interaction between inoculum ratio and fermentation time. The best experimental set required 62 percent initial moisture, 6.5 initial pH, 5 percent inoculum, 28°C incubation temperature and 3 days fermentation time. The maximum enzyme production under

these conditions was 1840 units/g, dry moldy bran, amounting to 28 percent increase due to optimization by response surface methodology.

BTM-78 ROLE OF PHYSICAL FORM OF THE CULTURE MEDIUM ON THE MASS PROPAGATION OF GINGER AND BANANA

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Shoot cultures from meristem explants of ginger and three cultivars of banana (genotypes AAA, AAB and ABB) were established on modified Murashige and Skoog medium with benzyl amino purine (BAP) at 0.5 $mg1^{-1}$ and indolebutyric acid (IBA) at 0.4 $mg1^{-1}$. These shoot cultures were allowed to grow on different types of media such as solid (**S**, agar-gelled), agitated liquid (**AL**, incubated on rotary shaker at 90 rpm) and static liquid (**SL**, liquid medium without continuous agitation). The **S** form was found superior to other forms of media in case of ginger, whereas **AL** and **SL** were better than **S** for banana. This was attributed to both ontogeny and phylogeny of the cultivars. The large aerenchyma and hydrophytic nature of banana supported its best growth in **AL** and **SL**, whereas ginger being a mesophyte performed well on **S**. However, in banana cultivars, a brief culture on **S**, prior to *ex vitro* planting improved the survival rate. The use of agar in large scale propagation not only adds to the cost of production, but also poses effluent problems. Considering all these parameters, a protocol was developed for large scale cost- effective propagation of banana cultivars.

BTM-79 ELICITOR ENHANCED ANTHOCYANIN PRODUCTION IN CARROT (*DAUCUS CAROTA*) CELL CULTURES

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Anthocyanin is a high value natural food colourant having a great potential in food industries. A stable mutant cell line of carrot (*Daucus carota*) which produces anthocyanin (16 percent on dry wt. basis) has been maintained in this laboratory since two years. The major anthocyanidins present were cyanidin mono- and di-glycosides. The colour was stable at pH range of 3- 5 in extracts and jam or jelly preparations. Anthocyanin production was enhanced by manipulating the media composition and by using elicitors. Various biotic and abiotic elicitors were tested for their effects on anthocyanin production. The biotic elicitors tested were the culture filtrates and biomass extracts of certain fungi, bacteria and yeasts. The abiotic elicitors tested were some divalent metal ions. In general, the biotic elicitors were more effective than abiotic elicitors and the extent of elicitation varied.

An increase in the production was attained with the extracts of *Aspergillus niger*, *A. flavus*, *Fusarium oxysporus* and *Rhodotorula rubra* which were 65, 114, 60 and 175 percent, respectively, compared to control. The increase in production with extracts of *Bacillus cereus*, *Pseudomonas aeruginosa*, *Escherichia coli* and *Staphylococcus aureus* ranged from 45 to 125 percent, over control. The abiotic elicitors like calcium, cobalt and iron enhanced anthocyanin production by 103, 63 and 77 percent, respectively. The elicitation process was governed by the type and level of elicitor.

BTM-80 ***KINEMA* - ITS PROXIMATE COMPOSITION AND MICROFLORA**

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Kinema, a soybean fermented alkaline food, is a meat substitute to a majority of the people of the eastern Himalayan regions. The moisture content of *kinema* was 63 percent (on dry matter basis). *Kinema* contained about 48 percent proteins, 17 percent fat, 28 percent carbohydrates and 7 percent ash and the energy value was 1.9 MJ/100 g. The corresponding values in raw soybeans were 11, 47, 22, 26, 5 percent and 2.0 MJ/100 g. While the pH of raw soybeans was neutral to slightly acidic (average 6.75), that of *kinema* was distinctly alkaline (average 7.89). Free fatty acids in *kinema* were about 90 times more than raw soybeans. A total of 502 bacteria isolate strains representing, *Bacillus subtilis* and *Enterococcus faecium*, and 198 yeast cultures representing *Candida parapsilosis* and *Geotrichum candidum* were isolated from 50 samples of *kinema*. *Bacillus subtilis* was the only microorganism recovered from raw soybeans. In *kinema*, *B.subtilis* was most dominant (3-5 x 10^8 cfu/g), followed by *E.faecium* (5-9 x 10^7 cfu/g) occurring in all market and laboratory-made samples. The population of *C.parapsilosis* occurring in 50-80 percent samples was 0.3-9.0 x 10^4 cfu/g, and that of *G.candidum* occurring in 40-50 percent of market samples was 0.8-4.0 x 10^4 cfu/g.

BTM-81 **STUDIES ON MODEL *IDLI* FERMENTATION WITH *SACCHAROMYCES CEREVISIAE* AND *LEUCONOSTOC DEXTRANICUM***

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Idli is a widely accepted traditional fermented food in India which is not only easily digestible, but also nutritious. Since the quality of this food varies from place to place, it was envisaged to improve the product to a consistent quality. As the fermentation of the *idli* batter (2:1 soaked and wet ground mixture of parboiled rice and blackgram *dhal*) by native microflora was characterized mainly by leavening and acid production, apart from the production of B-complex vitamins and amino

acids. A model fermentation with defined cultures like *Saccharomyces cerevisiae* and *Leuconostoc dextranicum* that contribute to these characteristics, respectively was studied in comparison with the natural fermentation. It was found that addition of these cultures at levels of 4×10^{11} cells and 1×10^{11} cells, respectively to 100 ml batter, not only reduced the fermentation time from 17 to 2 h, but also the pH, total acidity and volatile acidity were brought almost on par with those of natural fermentation. Comparison of yeast count, standard plate count and *lactobacilli* count were also made. Among various additives, sucrose (1 percent) was found to be better than the others which reduced further the batter doubling (fermentation) time with the defined cultures. Among various *idlis* prepared, the one with defined cultures and sucrose was better than the others, when subjected to a panel of judges for testing the overall acceptability in terms of colour, flavour and aroma. These results indicate the possibility of using well characterized starter cultures for the improvement of *idli* fermentation.

BTM-82 **INFLUENCE OF ORGANIC ACID ON FAT AND ALCOHOL PRODUCTION IN SHAKE AND STATIC CULTURES OF *FUSARIUM* spp.**

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The production of fat and alcohol by *Fusarium lycopersici*, *F. pallidoroseum* and *F. semitectum* was investigated in the presence of organic acids like malic acid, citric acid, succinic acid and tartaric acid under shake and static conditions at ambient temperature (27-30°C). In comparison with the control, the acids showed considerable repressive effect on the alcohol production in *F. pallidoroseum* and *F. lycopersici* in shake flasks. On the other hand, the fat production was enhanced in the presence of acids in these cultures under the same conditions. However, the acid had very little effect on fat and alcohol production under static conditions. There was negligible influence of these acids on *F. semitectum*. The paper also discusses the effect of organic acids on the fatty acid profile of fats, the biomass yield and on substrate utilization by the test organisms.

BTM-83 **STUDIES ON MICROBIOLOGICAL QUALITY OF INSTANT MIXES IN INDIAN MARKET**

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Several kinds of indigenous instant and ready-to-eat mixes are being marketed to the consumers in our country. The various steps involved in the preparation and distribution of these foods provide ample scope for contamination with spoilage and pathogenic microorganisms thus necessitating the microbiological quality assessment as an integral part of food industry. The microflora of ready-to-eat food items were studied. Accordingly, the food items were divided into two groups: the first group included foods like instant *upma* and *halwa* mix having low microbial count

primarily due to less or no spices used in them. There were no coliforms and had a total bacterial load of x 10^2/g, of the sample. The second group included foods like vegetable *pulav*, *Khichidi*, *Jamoon* mix, *Puliogre* mix, *Vada* mix having microbial counts of 10^2 to 5 x 10^4/g. Invariably, all the samples showed presence of *Staphylococci*.

BTM-84 BIOPESTICIDES OF PLANT ORIGIN AS PROTECTANTS OF GREENGRAM (*VIGNA RADIATA*) AGAINST *CALLOSOBRUCHUS CHINENSIS* L. INFESTATION

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The comparative efficacies of the extractives of some selected medicinal plant materials such as the rhizomes of *Acorus calamus*, *Alpinia galanga*, *Alpinia chinensis*, *Curcuma amada*, *Valeriana hardwickii*, *Valeriana wallichii* and the fruits of *Carum copticum* and *Embelia ribes* were evaluated against the pulse beetle, *Callosobruchus chinensis* infesting greengram, (*Vigna radiata*). The extractives of all the plant materials at 0.25, 0.5 and 1.0 percent levels assayed were found to be significantly superior to control in bringing about insect mortality, reducing grain damage, exhibiting anti-ovipositional and ovicidal properties. Among these, *A. calamus* treatment at low concentration of 0.5 percent was the most effective with respect to all the parameters tested after 24 h of exposure. *C. amada* and *C. copticum* treatments at 1.0 percent concentration recorded 91 and 94 percent mortality, respectively, only after 7 days. With regard to grain damage, samples treated with *C. amada* having 3 percent damage were next to *A. calamus*. However, there was no significant difference between *C. copticum*, *E. ribes* and *A. chinensis* treatments, wherein the grain damage was 11.5, 12.5 and 16.5 percent, respectively, compared to 57 percent in control, and it was observed to have a direct correlation to the emergence of F_1 generation. In samples treated with plant extractives at 1 percent concentration, the oviposition ranged from 0 to 41 percent, whereas it was 75 percent in control. Among all the plant materials tested *V. wallichii* was found to be the least effective in all respects. The plant materials used as grain protectants in the present investigation being safe to mammals, easily biodegradable and offer unlimited potential as pest control agents.

BTM-85 STUDIES ON SINGLE DETECTION METHOD FOR *SALMONELLA* IN FOOD

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Detection of *Salmonella* in food has great significance in the control of food borne infections. Since *Salmonella* is ubiquitous in nature, its presence in food and water needs to be controlled to prevent the outbreaks of epidemics. The present day microbiological analysis for *Salmonella* in food is a multi-stage process and take 4 to 7 days. A single stage *Salmonella* detection method was

developed making use of the ability of *Salmonella* to degrade propylene glycol and produce acid which can be detected employing suitable pH indicator. Propylene glycol-based liquid and solid meidum with neutral red indicator were used in the study. Serial dilution study has shown that *Salmonella* as low as one per g or ml could be detected by this method. Milk samples spiked with *Salmonella* were tested with this single stage method and could recover *Salmonella*. Thirty strains of organisms capable of degrading propylene glycol and producing acid were isolated. Utility of this medium for the detection of *Salmonella* in food will be discussed.

BTM-86 MICROBIAL AND SENSORY EVALUATION OF MINCED GOAT MEAT TREATED WITH SINGLE AND MIXED LACTIC CULTURES AND STORED AT REFRIGERATION TEMPERATURE

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Minced goat meat with mean aerobic plate count (APC) of log.10 5.26 (cfu/g) and psychrotrophic count of log.10 3.30 (cfu/g) was treated with lactic cultures - *Streptococcus lactis* (SL) *Lactobacillus bulgaricus* (LB) *L. planatarum* (LP), SL+LB, SL+LP, LP+LB or SL+LB+LP and stored at refrigeration temperature. The lactic cultures were inoculated at levels of log.10 6.5-7.5 (cfu/g). Treatments had a significant effect on APC. On 6th day of storage, LB+LP treatment had shown the lowest mean APC of log.10 5.15 (cfu/g). On 8th day of storage, SL+LP had shown the lowest mean APC of log.10 5.54 (cfu/g), whereas the controls had a mean count of log.10 6.54 (cfu/g). The growth of psychrotrophs was restrained from 6th to 8th day of storage. There was significant correlation of pH with APC in both treated and control samples. Total acidity was not significantly correlated with pH or microbial counts in both treated and control samples. Mixed culture treatments had shown higher sensory evaluation scores, than the other treatments and control.

BTM-87 STUDIES ON THE PRODUCTION OF 2 HEPTANONE (CHEESE FLAVOUR) BY *TRICHODERMA HARZIANUS* (T)

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Studies on the fermentative production of 2-heptanone by *Trichoderma harzianum* (T) were carried out. The organism was found to produce 2-heptanone from sodium octanoate. The

production was higher in potato-dextrose liquid medium than in Czapek-Dox medium. The yield in the former varied from 160-180 ppm, whereas in the latter it varied from 100-125 ppm. Of the different sugars tried, glucose gave the best results and 2- heptanone production was maximum reaching a value of 200 ppm. Xylose, lactose, sucrose and cellulose were found to support production of 180, 160, 115 and 50 ppm of 2-heptanone, respectively. Studies on the effect of varying concentrations of sodium octanoate, the fatty acid precursor indicated that 5mM concentration to be the optimum and the 2-heptanone yield was 325 ppm. Conditioning of the organism to the presence of octanoate at slants stage proved beneficial and the yield increased to 400 ppm. The present study conclusively proved that the organism can be fruitfully exploited for the production of blue cheese flavours under submerged conditions.

BTM-88 **MICROBIOLOGICAL PRE-TREATMENT OF FRUIT AND VEGETABLE PROCESSING WASTES FOR ENHANCED METHANE PRODUCTION**

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Fruit and vegetable processing wastes (FVPW) form a viable alternate feedstocks for methane production, but their recalcitrant physico-chemical nature hinders efficient bioconversion demanding the need for pre-treatment of the substrate prior to anaerobic fermentation. As an alternative to the economically inviable physical and chemical methods of pre- treatment, microbiological pre-treatment which may offer a more practical and environmentally safe approach was employed for pre- treating FVPW under solid state fermentation conditions. Biomethanation of FVPW pre-treated with selected strains of fungi, viz., *Sporotrichum*, *Aspergillus*, *Penicillium* and *Trichoderma* separately as well as in mixed consortium of these strains revealed that the pre-treatment of FVPW with a strain of *Sporotrichum* alone and the mixed consortium were more effective than the treatments with single cultures. Pre-treated mixed feed showed stable digestion with more than 100 percent increase in yields of biogas (0.600-0.750 cu.m/kg VS added) and methane (0.350-0.420 cu.m/kg VS added) over the untreated feed producing 0.320 and 0.160 cu.m/kg VS added, biogas and methane respectively, at 4 percent (TS) loading rate and a 30 day HRT. Manipulations in the operational parameters resulted in the use of enhanced loading rates (8 percent TS) and reduced HRT of 25 days as compared to control.

BTM-89 **SELECTION OF LACTIC CULTURES FOR FERMENTATION OF *DHOKLA* BATTER**

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This study was taken up to select lactic acid bacteria (LAB) for carrying out controlled fermentation in a short period in order to obtain consistent quality of fermented products such as *idlis*, *dhoklas* and *dosas*. Lactic acid bacteria were identified using standard methods. Out of the seven lactic cultures tested, *Lactobacillus lactis, Lactobacillus brevis, Leuconostoc mesenteroides* and *Lactococcus lactis* were observed to give acid and gas production within 6 h and hence were selected to study fermentation of *dhokla* batter. Each culture when inoculated (0.6×10^5 cells/20 ml batter) individually in the batter resulted in a good spongy texture and typical flavour within 5 h of fermentation period.

DAIRY SCIENCE

DRS-1 DEVELOPMENT OF PROCESSED CHEESE/CHEESE SPREAD FROM ACCELERATED RIPENED UF-CHEESE BASE

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Ultrafiltration (UF) is finding increasing application in the cheese industry. Since milk contains large proportion of water, the elimination of a portion of water for manufacture of cheese would facilitate handling and also increase the yield of cheese due to entrapment of whey proteins, reduce fat losses, require less starter culture and rennet. Ultrafiltration is successfully employed for the manufacture of soft varieties of cheese. In this study, attempts were made to utilize UF-concentrated milk for the development of cheese base which could be converted into processed cheese/cheese spread. The laboratory module of hollow- fibre membrane, Romicon (PM-50) was used for concentration of standardized pressures of 1.8 and 0.5 kg/cm^2, respectively. The cheese base was prepared from UF-concentrate (5 folds). The cheese base was ripened at 8$\pm$1°C. The flavour development and biochemical changes were enhanced by using Naturase at the rate of 5g/100 kg retentate. The study revealed that cheese base developed sharp flavour within 2-4 months. This base was satisfactorily utilized for the manufacture of processed cheese/cheese spread.

DRS-2 EFFECT OF LEVELS OF MEITO RENNET ON THE QUALITY OF MOZZARELLA CHEESE

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The formulation of rennet coagulated curd, the strength of gel matrix, its moisture holding as well as releasing properties are important to the progressive development of cheese during subsequent stages of cutting, cooking, stretching and moulding. The ideal coagulant used for cheese manufacture is calf rennet. The present investigation was carried out to study the effect of levels of Meito rennet on characteristics of Mozzarella cheese made from an admixture of buffalo and goat milk employing direct acid method. Goat and buffalo milks were mixed in equal proportions and acidified to pH 5.6 using diluted hydrochloric acid. The milk was set at 30°C with Meito rennet at 1.0, 0.75, 0.50 and 0.25 g/100 L milk. Mozzarella cheese was evaluated for its sensory, physico-chemical and textural attributes. The study revealed that among the four different levels of the coagulating enzymes, 0.75g/100 L milk was found to be the most suitable for making Mozzarella cheese of good quality. The body and texture of the cheese made using this level of rennet had the maximum score. The fat and TS recovered were the highest in the cheese made from 0.75g rennet per 100 L of milk.

DRS-3 RENNET COAGULATION PROPERTIES OF BUFFALO MILK, GOAT MILK AND THEIR MIXTURES

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Addition of goat milk due to its unique compositional properties may alleviate the flavour and ripening problems associated with buffalo milk cheddar cheese manufacture. The formation of desirable coagulum and controlled expulsion of moisture are of prime importance for monitoring curd curing characteristics which, in turn, influence the final cheese quality. The coagulum properties are largely dependent upon the rennetting behaviour of milk and need to be thoroughly investigated. The thrombelastograph (Mellige GmbH, West Germany) similar to formagraph was used to determine the coagulation characteristics of milk. Rennet concentration and coagulation time had linear relationship at low enzyme concentration and reached a limiting value at high enzyme concentration. The optimum concentration of calf, Meito and Hannilase was found more in case of buffalo milk. Goat milk had lower coagulation time than buffalo milk regardless of type of rennet and its concentration. Buffalo milk resulted in firmer curd than the goat milk, regardless of the type of rennet and its concentration. Buffalo milk produced the maximum firmness of 84, 81 and 88 mm with calf, Meito and Hannilase rennets, respectively, while values for goat milk were only 36, 45 and 40 mm. Thus, addition of goat milk to the buffalo milk reduced the coagulation time and firmness and optimum level of rennet requirement was less than in pure buffalo milk.

DRS-4 EVALUATION OF FLEXIBLE PACKAGING MATERIALS FOR "IN-PACK" STERILIZATION OF *PANEER*

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In a bid to replace the conventional rigids of "in-package" sterilization of milk and milk products, an investigation was directed to the evaluation of certain flexible packaging materials available in India for "in-pack" sterilization of *paneer*. *Paneer* was formed from concentrated milk (Fat:SNF::5:25) through incorporation of GDL and nisin in five types of flexible packages: (i) high density polyethylene (HDPE); (ii) polypropylene (PP) of varying thickness viz. 50 μm, 62.5 μm and 75 μm and (iii) retort pouch - a three-ply laminate consisting of polyester/Al foil/PP (12/12/75 μm) and subjecting to texturization process at 115-121°C for 5-15 min. The maximum temperature withstanding limits of the five packages tested were found to be 115°C/5 min, for (i) and (ii-50 μm); 118°C/5 min. for (ii-62.5 μm; 121°C/5 min. for (ii-75 μm); and 121°C/10 min, for (iii). No seam gap and holes/cracks in the pouch body were observed and product shelf-life was 20, 20, 45, 60 and 90 days, respectively in packages (i) to (iii) when stored at 35°C. However, when (ii-62.5 μm) was subjected to 118°C/10

min. or (iii) to 121°C/15 min., elongation of the material in the body of the pouch was observed in (ii-62.5 μm) and seam gap test was positive in approximately 90 percent of pouches accompanied by delamination in (iii). Thus, PP film (75 μm) and retort pouch can be successfully employed for "in-pack" sterilization of paneer.

DRS-5 A STUDY ON THE PRESERVATION OF RAW MILK THROUGH ACTIVATION OF LP-SYSTEM

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An investigation was carried out to evaluate the extension in the keeping quality of fresh cow and buffalo milks on the basis of various quality tests treated by six levels of LP-Systems, viz., 15 : 10, 25 : 15, 30 : 15, 40 : 20, 60 : 25 and 75 : 30 (being the ratio of SCN and H_2O_2 levels, respectively) and stored at 30°C. A keeping quality of 6 h, 6 h, 10 h and 5.5 h, respectively was observed in case of untreated cow milk and 4 h, 4 h, 6 h and 3.5 h, respectively in case of untreated buffalo milk on the basis of titrable acidity, alcohol stability, C.O.B. and 30 min. - MBR test. The optimum concentration and proportion of SCN and H_2O_2 for activation of LP-System was found to be 75:30 in both cow and buffalo milk. When treated with 75:30 LP-System the keeping quality was observed to be 12 h, 12 h, 12 h and 9 h in case of cow and 10 h, 8 h, 10 h and 5.5 h, respectively in case of buffalo milk with respect to titratable acidity, C.O.B. and 30 min-MBR test.

DRS-6 WHEY - JEERA BEVERAGE

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In an attempt to produce an acceptable quality whey-based beverage fresh buffalo-milk-*paneer*-whey was standardized to whey-jeera (Cumin) beverage (WJB) by adding sugar, spices, citric acid, salts and jeera essence. The fresh products contained on an average, fat 0.32, protein 0.42, reducing sugars 4.16, non- reducing sugars 3.95, ash 1.5 and total solids 9 percent. The pH, acidity (percent), and turbidity (O.D.) of the fresh product on an average were 3.92, 0.64 and 0.74, respectively, while the standard plate count (SPC) was 22.7 x 10^3/ml. Acceptability on 9-point Hedonic scale by a panel of judges was 7.3. A four week storage study indicated that physico-chemical changes in the beverage at low temperature (5±2°C) were less as compared to room temperature (30±1°C). Carbonation of the beverage enhanced its acceptability, while addition of sodium-benzoate at 300 ppm enhanced its shelf-life.

DRS-7 MATHEMATICAL MODELS BASED ON KINETIC DATA FOR SHELF-LIFE PREDICTION OF UHT MILK

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The kinetic approach to predicting food quality deterioration involves mathematical model building. The variables were selected on the basis of co-efficients of determination of the multiple regression equations for various chemical, biochemical and physical parameters that affect flavour changes. The multiple regression equations so selected were integrated with the functions of temperature dependence for the variables (R^2 = 0.9134 for reflectance at 450 nm and TBA value) and established between the corresponding rate constants and temperatures of storage. The mathematical structures of third order reaction kinetics were also introduced in the predictive mathematical design. The model could be written as:-

$$FS = 0.0101 \left[\sqrt{\frac{1}{1 + (8.1795 \times 10^{-11} \cdot e^{0.0613T} \cdot t} R_o} \right]^{1.9375} \left[\{ e^{[117.7320 - 0.86184T + 0.0015361T^2]} t + 1 \} TBA_O \right]^{-0.1176}$$

where, FS = Flavour score, T = Temperature (^oK), t = Storage period (weeks), TBA_o = TBA value at t = 0, R_o = Reflectance value at t = 0.

The model was tested by comparing the predicted and observed data of UHT milk stored at steady and variable temperature conditions. The RMS percent (root mean square error analysis) for 9, 15, 25, 35, 45 and 55°C storage temperatures were 4.1, 4.0, 3.4, 2.6, 5.0 and 9.0 whereas it was 5.4 for non-steady state storage sequence. The model developed should find potential applications in commercial UHT plants where large batches of production are marketed to diverse marketing destinations.

DRS-8 QUALITY AND SHELF-LIFE OF GOAT MILK *PANEER* UNDER REFERIGERATED STORAGE

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Paneer, which is a semi-hard type of cheese, was prepared by curdling Barbari milk (4.97 percent fat, 13.56 T.S. percent) at 87-88°C with 0.1% citric acid. The product with a yield of 15.65

percent, had 46.9 percent moisture, 26.9 percent fat and pH value of 5.91. Fresh *paneer* had no off-odour. Overall appearance was highly appealing with characteristic creamy white colour. The moisture content and pH value did not change much during refrigerated storage (4± 1°C) for a period of 0, 3 and 7 days. Marked increases in SPC, proteolytics, *Staph. aureus*, psychrotrophs, coliforms and yeast and mold counts were observed after 3rd day of storage. Changes in organoleptic traits were noticed on 7th day of storage. Results of this study suggested that good quality *paneer* from goat milk can be prepared and stored safely under refrigeration for 3 days.

DRS-9 KEEPING QUALITY OF GOAT MILK AT AMBIENT TEMPERATURE

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The keeping quality of goat milk from Jamunapari and Barbari was studied at ambient temperature in rainy (32.4± 0.38°C) and winter (18.9±0.52°C) seasons. Physico-chemical and microbiological parameters were studied from approximately 2 h after milking to 9 or 24 h (in winter). Fat and total solids in Barbari and Jamunapari during the rainy season were 4.5±0.13 percent; 12.6±0.44 percent and 5.9± 0.32 percent; 13.8±0.29 percent, respectively. In winter, these values were, 5.6±0.12 percent, 13.9±0.25 percent and 4.6±0.11 percent and 12.6± 0.10 percent respectively. The level of bacterial contamination (log_{10} cfu/ml) was high in rainy season (Barbari - 5.7±0.24; Jamanapari - 6.0±0.10) as compared to winter (Barbari - 5.3±0.33; Jamanapari - 5.0±0.37). Initial counts significantly varied between trials. Average coliform counts were above the permissible limits of less than 10 per ml. in both the seasons. Alcohol coagulation tests were negative at 9 h for all the samples in winter. However, at 24 h, 40 percent of Barbari samples and 20 percent of Jamanapari samples were positive. These results indicated an extended shelf-life of goat milk at lower ambient temperature during winter which could be due to the lower initial counts as well as the reduced rate of bacterial multiplication.

DRS-10 PERFORMANCE OF UPFLOW ANAEROBIC PACKED BED REACTOR FOR TREATMENT OF DAIRY INDUSTRY EFFLUENT

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Due to the present high cost energy and the energy intensiveness of wastewater treatment, considerable attention is being shown to anaerobic system. Laboratory studies were conducted on an anaerobic reactor packed with cubes of foam of size 15 mm for the treatment of dairy wastewater. The effect of recirculation on the performance of upflow anaerobic packed bed reactor process for the treatment of dairy industry effluent was investigated. The effluent was fed to the reactor at 24.4 h retention time. The recycle ratio was maintained between 6 and 19. The chemical oxygen demand (COD) removal was increased from 65.25 to 80.32 percent with the increase of recycle ratio from 6

to 19. The maximum values of biogas productivity and specific biogas productivity were 0.0303 ml/ml d, 0.0335 ml/mg COD reduced, respectively.

DRS-11 QUALITATIVE CHANGES IN PROTEIN DURING PREPARATION OF WHEY PROTEIN CONCENTRATES

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The functionality of whey protein concentrates (WPCs) depend, upon the type and nature of protein present. Keeping in view, the fact that, the qualitative differences in protein make up exists among the different types of WPCs, they were assessed by Gel filtration (using G-100) Disc-Poly Acrylamide Gel electrophoresis (Disc-PAGE) and Sodium Deodcyl-Sulpahte-Poly Acrylamide Gel electrophoresis (SDS-PAGE) Technique. The WPCs were prepared from cheese whey by five methods: Cold precipitation using sodium hexa meta phosphate (SHMP) and carboxy methyl cellulose (CMC), gel filtration (GF), ion exchange chromatography (IE) and ultra filtration (UF). The GF-WPC and UF-WPC showed similar Gel filtration, Disc-PAGE and SDS-PAGE profile as that of native whey protein. The Gel filtration on Sephdex G-100 showed that IE-WPC eluted in a single fraction which corresponds nearly to void volume. Disc-PAGE showed IE-WPC did not resolve into any component, but showed streaking and SDS- PAGE showed additional bands having molecular weights 30550 and 22390. This shows that the protein in IE-WPC undergoes variations due to association of Beta-1g and Alpha-1a. The protein in SHMP-WPC and CMC-WPC showed denaturation upto varying degrees. The high molecular weight protein such as immunoglobulins are not precipated by SHMP and CMC as revealed by GF through G-100 and SDS-PAGE. Disc-PAGE revealed that an incomplete resolution of CMC-WPC due to residual CMC which affected the viscosity and protein charge.

DRS-12 SENSORY, COMPOSITIONAL AND INSTRUMENTAL CHARACTERISTICS OF *CHURPI*

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Churpi is a heat and acid coagulated milk product traditionally consumed as a chewing gum in the district of Darjeeling of West Bengal, Sikkim, Nepal, Bhutan and Tibet. Organoleptically, the *churpi* of Bhutan had a high score. The samples from Bhutan had less moisture, total fat, free fat, water-dispersible protein and titratable acidity, but higher total protein and ash contents compared to those from Darjeeling and Sikkim. The samples of Bhutan exhibited greater hardness (993.7 N), cohesiveness (0.6), springiness (0.76 mm), gumminess (584.4 N) and chewiness (442.1 N.mm) than the other samples.

DRS-13 EFFECT OF PROCESSING PARAMETERS ON QUALITY OF *PANEER* FROM BUFFALO MILK

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In view of the increasing popularity of *paneer*, an attempt was made to standardise the method of its preparation from buffalo milk, with reference to different fat levels (5.4, 5.6, 5.8 and 6.0 percent); heating temperature (80, 85, 80 and 85°C); holding times (0, 5 and 10 min.) and coagulants (citric, tartaric, lactic acids and their combinations). The parameters considered were fat on dry matter basis (FDM), total solids recovery and organoleptic quality. Different concentrations of antimicrobial agents viz. brine solution (5, 6 and 7 percent); hydrogen peroxide (300, 450 and 600 ppm); potassium sorbate (1, 2 and 3 percent); chlorine (30, 40 and 50 ppm); acidified brine solution (5.0, 5.5 and 6.0 pH) as dipping solutions for *paneer* were evaluated for their ability to increase the shelf-life at 10°C storage. On the basis of standard plate count, yeast and mold counts and coliform counts, brine solution (6 percent); hydrogen peroxide (600 ppm); potassium sorbate (2 percent); chlorine (40 ppm); and acidified brine solution (5.0 pH) were found to be most suitable antimicrobials. However, storage studies revealed that antimicrobial activity was the best in hydrogen peroxide followed by chlorine, potassium sorbate, brine solution, and acidified brine solution.

DRS-14 EFFECT OF HURDLES ON RHEOLOGICAL CHARACTERISTICS OF FRIED *PANEER*

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Effect of four hurdles, viz., water activity (range, 0.90-0.98), pH (range, 4.7-5.9), heat treatment (range, F-value 0.2-0.8) and potassium sorbate (PS) (range, 0-0.1 percent) on texture profile and viscoelastic properties of fried *paneer* which was processed at above hurdles and stored in tins at 30°C was investigated. These properties were noticeably altered, either increased or decreased, depending on the intensity of hurdles. Hardness varied from 95.0-1360 mN, cohesiveness from 0.212-0.397, gumminess 31.3-388.1 mN, springiness 3.0-9.8 mm and chewiness 115.0-2289.2 mN.mm. The reaction rates of change of textural parameters during storage varied from 0.0001-0.0477 per day. Maximum changes occurred in viscoelastic parameters and chewiness. Rheological characteristics and their rates of changes during storage of fried *paneer* could be predicted using response surface equation for a given set of hurdles. This will help in selecting such hurdles which will impart minimum textural damage to fried *paneer*.

DRS-15 CHARACTERIZATION OF WATER SORPTION PROPERTIES OF *PANEER*

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Water sorption properties of raw and fried *paneer* and sigmoid and type II were studied. Increase in sorption temperature tended to decrease equilibrium moisture content. Water activity at given moisture content of *paneer* also increased with temperature, but after water activity (0.86), this effect diminished. Of eight equations tried, modified Mizrahi equation fitted best to the sorption data followed by GAB, Oswin and Caurie equations. Depending on the sorption temperature and the moisture content, percent bound water, density of bound water, surface area and pore size of raw and fried *paneer* varied from 11.8643 to 22.6818 and 9.3457 to 19.5921, 0.9016 to 1.0944 and 0.8670 to 0.9672 g/cc, 98.69 to 124.00 and 89.42 to 122.55 m^2/g. 3.95 to 41.40 and 4.02 to 20.39 A^o, respectively. Frying process decreased percent bound water, density of bound water and surface area of adsorbent. Increase in temperature also had similar effect. *Paneer* exhibited type 'C' hysteresis. The total hysteresis energy at 25°C was 35.83 kJ/kg water and 6.62 kJ/kg water for raw and fried *paneer*, respectively.

DRS-16 DEVELOPMENT OF SHELF-STABLE READY-TO-EAT *PANEER* CURRY USING HURDLE TECHNOLOGY

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Ready-to-eat *paneer* curry consisting of gravy and *paneer* cubes was developed using Hurdle Technology concept. The gravy was prepared using onions, tomatoes, usual spices and condiments in which fried *paneer* cubes were suspended. The product was packed either in tins or retort pouches and heat treated at F-value of 0.8. A set of hurdles, viz., water activity (0.95), pH (5.0), F-value (0.8) and potassium sorbate (0.1 percent) which combinedly had a maximum lethal effect on *Bacillus* spores and minimum effect on textural and chemical characteristics during processing, as well as storage of *paneer* were chosen. Water activity of *paneer* and gravy was lowered using humectants, such as *dahi*, skim milk powder (SMP), salt and glycerol. pH was adjusted by changing *dahi*: SMP ratio. The resultant product had a keeping quality of about one month at 30°C and over 3 months at 15°C. The product was compared with fresh samples from restaurants and was found to be equally acceptable. This method of preservation had a large scope for alterations in product formulations according to regional taste preferences without affecting the keeping quality.

DRS-17 CHARACTERIZATION OF NATIVE PROTEINASES IN COW AND BUFFALO MILK

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Native proteinases isolated from acid precipitated casein were purified on DEAE sepharose-6B and estimated fluorometrically using FITC labelled casein. Optimum activity was noticed at 37°C and an increase in activity was observed with high citrate content in both cow and buffalo milk proteinases. Cow and buffalo milk proteinases were eluted with 0.1M and 0.3M NaCl, respectively. Presence of Ca^{++} was necessary for buffalo milk proteinase activity. Further the optimum pH activity of cow milk proteinases was 7.8 and for buffalo milk it was 6.8 which was nearer to the normal pH of milk. The Km for cow milk proteinases was 0.285 mM, at pH 7.8 and 0.4 mM at pH 6.8, whereas for buffalo milk proteinase, the K_m was 0.8 mM at pH 7.8 and 0.266 mM at pH 6.8. Cow milk proteinase had higher activation energy (15.66 Kcal/Mole) than the buffalo milk proteinases (12.76 Kcal/Mole). These results may indicate the reason for the differences between native proteinases from cow and buffalo milk which may be of importance in UHT milk industry.

DRS-18 PRODUCTION OF LONG SHELF LIFE CHEESE DIPS

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The cheese dips are relatively high moisture products and hence have low shelf-life. The cheese dip was prepared by mixing cheddar cheese (Moisture 43 percent), *chhana* (Moisture 70 percent), cream (Fat 40 percent) in 5:3:2 proportion. Salt (3 percent) was added for taste. Sodium citrate and glyceryl monostearate (1 percent) were added to obtain desired body and texture characteristics. The product was heated to 85°C/10 min to enable proper mixing and then was bottled and autoclaved at 10 psi/10 min to increase the shelf-life. It was observed that, the minimum moisture in cheese dip should not be less than 62 percent to retain the product in easy flowing state. The relative viscocity of such product measured at 30°C was observed to be approximately 31 times that of water. Autoclaving the product at higher time-temperature combination resulted in intense brown colour. The final composition of the cheese dip was moisture, 62-65 percent, fat 22-24 percent, protein, 11-13 percent and lactose, 1-2 percent. The sensory evaluation of the product indicated that the product was highly acceptable both as dip and spread.

DRS-19 TECHNOLOGY OF CHOLESTEROL-FREE MOZZERELLA CHEESE

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Mozzarella is a soft unripened variety of cheese used commonly in the preparation of *Pizza*. The cheese was prepared from filled milk using sunflower oil as the filler fat. The milk was homogenised in one stage at 35 bar pressure at 50-55°C and pasteurised at 63°C/30 min. Addition of 0.05 percent calcium chloride to the milk before homogenisation improved the body and texture characteristics. Direct acidification (pH 5.6) with dilute citric and acetic acids resulted in better quality cheese compared to the conventional (cultural) method. The cheese prepared by using citric acid was softer compared to the cheese prepared by using acetic acid. The melting characteristics of filled milk cheese compared well with control cheese made from unhomogenised cow milk containing 3 percent fat. The fat leakage was, however, lower in experimental cheese compared to control. The unsalted cheese packed in polyethylene pouches kept well for 8-10 days at 8-10°C and for about 90 days in deep-freeze. The stretching characteristics deteriorated while melting quality improved with increase in storage time at both the temperatures. The final composition of filled Mozzarella cheese was moisture 52-63 percent, fat, 25-28 percent, protein, 22-28 percent, and ash 0.6-1.2 percent.

DRS-20 ENERGY CONSERVATION IN THE PROCESSING OF WHEY FOR WHEY POWDER BY REVERSE OSMOSIS TECHNOLOGY

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Concentration of whey for the production of whey powder was carried out by using AFC-99 tubular type Reverse Osmosis Plant. Amongst various levels of pH of whey, adjusting *paneer* whey and buffalo milk cheddar cheese whey to pH 7.2 and heating to 80°C/15 sec, resulted in significantly higher flux (l/m^2/h), as against pH values of 3.5, 4.5, 5.6 and 6.4. However, in case of cow milk cheddar cheese whey, processing at native pH (6.3), resulted in higher flux compared to other pH values. A total solids of 20.5, 22.10 and 23.20 percent were the maximum that could be attained. However, from economic point of view, concentrating *paneer* whey to 2-fold and cheese whey to 2.5-fold was found to be optimum, with an average flux of 35.28, 38.25 and 39.80 l/m^2/h, respectively for *paneer* whey, cow milk cheddar cheese whey and buffalo milk cheddar cheese whey. The concentration of whey by reverse osmosis followed by vacuum evaporation and spray drying, resulted in savings in energy amounted to 50.79, 63.09 and 63.99 percent compared to direct evaporation and spray-drying.

DRS-21 PRODUCTION OF FUNCTIONAL WHEY PROTEIN CONCENTRATE BY ULTRAFILTRATION

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Buffalo milk cheddder whey (BW) was fractionated at 50°C through a Hollow fibre ultrafiltration plant possessing polysulphone PM 50 membrane. Amongst various pretreatments of whey adjusting BW to either a pH of 7.2 or 3.0 and heating to 80°C/15 sec., resulted in significantly higher flux ($P \leq 0.01$) than at its native pH (6.4), as well as other pH values (4.5, 5.6). Though the flux at pH 7.2 was relatively higher than at pH 3.0, the reusultant whey protein concentrate (WPC) had lower ash content (6.24 percent) compared to that at pH 3.0 (13.17 percent). Maximum volume reduction attainable was 97.5 percent. However, for economic operation, a volume reduction of 95 percent was optimum which had a protein content of 64 percent. By diafiltration, as high as 85.92 percent protein was attained, while the ash and lactose contents reduced to values as low as 2.14 and 4.60 percent, respectively. The results revealed that depending on the end use, the composition of WPC could be altered by monitoring the volume reduction and by varying the pH of whey.

DRS-22 *PANEER* MANUFACTURE EMPLOYING ULTRAFILTRATION

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Ultrafiltration, when employed for *paneer* manufacture offers access to mechanisation, uniformity of production, improved shelf-life, increased yield and a nutritionally better product. The process involved standardisation of buffalo milk to 5 percent fat, heating to 50°C followed by 4- fold concentration using ultrafiltration with simultaneous removal of lactose, minerals and water. The concentrated mass having around 40 percent total solids was cooled to 12°C, acidified with 20 percent citric acid solution to a pH of 5.5 and then filled into suitable containers. This was followed by texturisation using microwave technique and the resulting product had typical characteristics of normal *paneer*. The yield was increased by about 25 percent which was due to the retention of good quality whey proteins and a slightly increased moisture content.

DRS-23 DEVELOPMENT OF LOW-OLIGOSACCHARIDE SOYGHURT

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Soymilk is not widely accepted mainly because of its distinct beany flavour and due to the presence of flatulence factors like stachyose and raffinose. These oligosaccharides can be reduced by the action of alfa-galactosidase through germination or by lactic fermentation. However, complete elimination of soy- oligosaccharides by either process is not techno-ecnomically feasible. A process was standardised incorporating a suitable combination of germination and lactic fermentation to develop an acceptable soy milk based fermented product.

Whole soy beans were steeped in water for 12 h followed by germination at 25±2°C for 72 h. Soy milk was extracted from germinated soy beans using whey (pH 6.6) in place of water. The whey used germinated soy milk (WGSM) contained 3.85 percent protein, 1.6 percent fat, 11.05 percent total carbohydrate, 0.9 percent ash and 82.6 percent moisture. For the preparation of fermented product, 2 percent inoculum of *Lactobacillus plantarum* and *Streptococcus thermophilus* (2:1) was added to pasteurized WGSM (17.4 percent TS) and then incubated at 44±1°C for 4 h. The product exhibited an acidity of 0.71 percent LA and total count of 9.7×10^7 cfu/ml. Soyghurt with added fruit (15 percent) and sugar (12 percent) was organoleptically superior to plain soyghurt.

DRS-24 BIOCHEMICAL, TEXTURAL AND ORGANOLEPTICAL CHARACTERISTICS OF VEGETARIAN CHEESE MADE FROM COW:SOY MILK BLENDS USING MODILASE

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The modern technology developed for manufacturing cheese has been confined generally to cow milk due to compositional superiority. Large scale production of cheese in India is limited both by availability of cow milk and rennet. Soybean contains 38-42 percent proteins and 18-20 percent fat and therefore, provide an excellent and economic source of energy and quality proteins. Cheddar cheese was prepared from cow; soy milk blends (95:5, 90:10, 85:15, 80:20 and 75:25) using modilase enzyme and ripened at 8±1°C (E.R.H. 75-80 percent) for 240 days. Soy cheese was compared with cheese made from cow milk using calf rennet and modilase for biochemical, organoleptical and textural characteristics during ripening. The replacement of soy milk upto 15 percent did not show any significant difference ($P<0.01$) in the sensory properties of cheese. However, during ripening, the samples made with even 5 percent soy milk differed significantly. The regression analysis showed that the ripening period was highly positively correlated with flavour, body and texture and highly negatively correlated with colour. The increase in soy solids proportion showed a decreasing

effect on hardness, springiness, gumminess and chewiness. These textural characteristics of all the cheese samples first increased upto 120 days and thereafter they decreased but reverse was true for cohesiveness of cheese during ripening. From the results of this investigation, it can be concluded that enzyme modilase can replace calf rennet in cheese making. Cow milk can be replaced to the extent of 15 percent with soy milk without affecting the sensory characteristics of cheese adversely.

DRS-25 EFFECT OF CARDAMOM ON THE SHELF-LIFE OF SANDESH

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Cardamom is known to improve the flavour of foods. The aromatic compounds present may exert an antiseptic property. Since cardamom is quite popular as a natural flavouring agent, its role in preserving *sandesh* was studied. The influence of three levels (0.05, 0.10 and 0.15 percent) of cardamom on the chemical, microbiological and sensory qualities of *sandesh* during storage at 30 $\pm$ 1° and 7 $\pm$ 1°C were investigated. Addition of cardamom brought about a significant improvement in the storage quality of *sandesh*. Samples prepared with 0.15 percent cardamom showed the minimum chemical deterioration both at 30°C and 7°C. The rate of spoilage was found to be higher at 30°C than 7°C. *Sandesh* samples treated with 0.15 percent cardamom showed minimum microbial counts. The proliferation of microorganisms was greater at 30°C than 7°C. Addition of cardamom also markedly improved the flavour of *Sandesh* at both the storage temperatures. The highest and lowest sensory scores were observed in *sandesh* samples incorporated with 0.10 and 0.05 percent of cardamom, respectively. Addition of 0.15 percent cardamom produced too much aroma in the finished product. On the basis of these studies, it was suggested that incorporation of 0.10 percent of cardamom may be useful to improve the sensory and shelf-life characteristics of *sandesh*.

FOOD CHEMISTRY AND NUTRITION

FCN-1 IMMUNO-SUPPRESSIVE AGENT IN HEATED GHEE

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Clarified butter or ghee is being consumed as such in foods or used for the preparation of delicacies involving roasting or deep-fat-frying. Prolonged heating of fats, in general, is known to result in the generation of substances which are likely to be toxic to consumers. In the present study, an attempt has been made to detect the generation of such toxic substances and to study their influence on cell-mediated immune reactions in mouse. One of the components extracted from the non-saponifiable fraction of heated ghee extract inhibited nitrogen induced lympho-proliferation of spleen cells in a dose dependent manner and the inhibition was more pronounced at 72 h than at 24 or 48 h of culture. It was toxic to RDM-4 lymphome cells in culture. Results indicate the presence of a compound in the heated ghee extract which has immuno-suppressive activity. Further isolation and characterisation of the active compound is under progress.

FCN-2 CHANGES IN VITAMINS AND *IN VITRO* PROTEIN DIGESTIBILITY OF FERMENTED PRODUCTS

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Khaman and Mothbean *vada* were prepared by fermentation process. Khaman batter was steam-cooked, whereas mothbean batter was fried to obtain final product. Fermented batter and final products were analysed freshly and after drying. The results showed an increase in thiamine, riboflavin, vitamin C and total nitrogen, and decrease in *in vitro* protein digestibility due to fermentation of flour. Drying of fermented batter showed decrease in thiamine, riboflavin, vitamin C and total nitrogen, but increase in *in vitro* protein digestibility. Steam- cooking showed greater decrease in thiamine and vitamin C, whereas frying showed greater decrease in riboflavin. *In vitro* protein digestibility of freshly cooked khaman was 7 and 38 percent higher and mothbean *vada* was 8 and 32 percent higher compared to raw flour and freshly fermented batter, respectively.

FCN-3 EFFECT OF TEMPERATURE AND DURATION OF HYDRATION ON SOME TEXTURAL PROPERTIES OF SOYBEAN

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Textural characteristics mainfest themselves either during food processing or consumption and also govern the acceptability of food by the consumer. The values of different textural parameters viz., hardness, cohesiveness and springiness for blanched soybean were determined from the force-deformation curve using Bourne's technique. The hardness, cohesiveness and springiness together constitute the texture of grain under repetitive compression and relaxation to which a grain is normally subjected under human teeth during eating. These three parameters of the grain together form the textural profile thus simulating the mouth feel during process of chewing of grain for ingestion and were measured at different hydration temperatures, 323 to 353K and duration of hydration, 15 to 300 min. A multiple regression analysis showed a non-linear function of time and temperature of hydration for all the 3 textural parameters. The hardness of the grain varied from 33.16 to 79.46 N, cohesiveness 0.42 to 0.90 and springiness 1.0 to 1.88 mm for the various levels of different process variables studied. A multiple regression models developed for these textural parameters as a function of time and temperature of blanching can be used for determining the blanching conditions for obtaining any desirable texture of the product.

FCN-4 EFFECT OF CURCUMIN AND EUGENOL ON LIPID PEROXIDATION AND REACTIVE OXYGEN SPECIES

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Lipid peroxides are deleterious to health as they are involved in many pathological conditions such as cardiovascular, auto-immune and inflammatory disorders. Lipid peroxides are regulated by the dietary components such as lipid and antioxidants like vitamin E and selenium. Recently, we have observed that there are some spice principles, e.g., curcumin from turmeric and eugenol from clove in Asian diets effectively control the levels of lipid peroxides. Dietary curcumin (1 wt percent) and eugenol (0.17 wt percent) fed to rats for 10 weeks reduced the lipid peroxide levels in liver homogenates and microsomes enhanced the antioxidant enzymes such as superoxide dismutase, catalase, glutathione peroxidase and glutathione transferase activities. The effect of curcumin and eugenol on reaction oxygen species which initiates lipid peroxidation was tested. Curcumin (5 to 50 n moles) and eugenol (25 to 200 n moles) scavenge superoxide and hydroxyl radicals in the model

systems in a dose-dependent manner. Curcumin and eugenol also inhibited hydrogen peroxide induced oxidation of ferrous ions in a dose-dependent manner. The results suggest that the spice principle inhibit lipid peroxidation by scavenging reactive oxygen species and enhancing the antioxidant enzyme activities.

FCN-5 **BILIARY AND SERUM LIPIDS IN RATS FED WHOLE MANGO GINGER (*CURCUMA AMADA* Roxb.) AND ITS COMPONENT LIPID PORTION**

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In continuation of our studies on the effects of mango ginger on rats, the components like lipid portion and the lipid free curcumin containing portion were studied with regard to cholesterol absorption, serum cholesterol and biliary lipid secretion. When rats were fed 10 percent lipid-free curcumin containing portion or 0.3 percent lipid portion (equivalents of 10 percent dry mango ginger) in a normal diet for 5 weeks, the liver total cholesterol was significantly lowered by the lipid portion as well as by mango ginger. Cholesterol absorption was not affected by mango ginger or by either component, whereas the biliary secretion of lipids, particularly total bile acids were increased, the liver and serum total and (LDL + VLDL) cholesterol were lowered in rats fed with cholesterol diet supplemented with mango ginger and either portion. There was an increase or a tendency to increase in HDL cholesterol and HDL/total cholesterol. The component lipid portion exerted an influence on liver and serum lipids even at dietary levels of 0.1 and 0.05 percent.

FCN-6 **INFLUENCE OF A HYPOCHOLESTEROLEMIC SPICE PRINCIPLE CURCUMIN ON KIDNEY INTEGRITY/LESIONS IN DIABETIC RATS**

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Curcumin, the active principle of turmeric is a well recognised hypocholesterolemic food additive. Alteration of the blood cholesterol levels is presumed to affect vascular changes including nephropathy in diabetic condition. In the present investigation, the influence of curcumin and high cholesterol diets on kidney integrity and on the extent of renal damage in streptozotocin-induced diabetic rats was studied. Renal damage was assessed by the amount of protein and enzymes excreted in the urine. The functional status of the kidney was assessed by measuring the activities of various enzymes involved in the metabolism in the kidney tissue. The results indicated that 8 week curcumin feeding (at 0.5 percent level) showed hypocholesterolemic effect in diabetic rats. Urinary excretions of proteins and enzymes by diabetic rats were significantly lowered by dietary curcumin. Similarly, alterations in the renal enzyme activities were somewhat ameliorated under the

influence of dietary curcumin. Data are suggestive of beneficial effect of curcumin with respect to renal tubular damage associated with diabetes.

FCN-7 INDIGENOUS FERMENTATION OF RICE-BENGAL GRAM DHAL BLEND: CHANGES IN DIGESTIBILITY (*IN VITRO*) AND LEVEL OF PHYTIC ACID

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Fermentation of rice-Bengalgram *dhal* blend (50:50) with butter milk at 25, 30 and 35°C for varying periods i.e., 12, 18 and 24 h brought about a drastic reduction in the phytic acid content and significantly improved the protein and starch digestibilities (*in vitro*). The phytate content of rice-Bengal *dhal* blend was 255.2 mg/100g and after fermentation at 35°C for 24 h, it was reduced to 123.9 mg/100 g. The percent decline in phytic acid varied from 6 to 51; maximum being at 35°C for 24 h. The digestibilities of starch and protein of the fermented products were enhanced to the extent of 5 to 18 and 10 to 31 percent over the control values, respectively. Higher the temperature and longer the period of fermentation, the more was the decrease in phytic acid content and greater was the improvement in digestibility. A significant negative correlation was found between the phytic acid content and digestibilities of starch and protein of the fermented cereal-legume blend.

FCN-8 FERMENTATION OF DEHUSKED BARLEY-DEFATTED SOYFLOUR BLEND: AN IMPROVEMENT IN HCL EXTRACTABILITY OF MINERALS

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Buttermilk fermentation at 25, 30 and 35°C for 12, 18 and 24 h brought about a significant improvement in the HCl extractability of dietary essential minerals in 0.03N HCl, an index of their bio-availability to human system. As a result of fermentation, a significant increase in non-phytate and HCl extractable phosphorus occurred with a corresponding decline in phytate phosphorus of dehusked barley-defatted soyflour mixed in 50:50 proportion. The extractability of calcium, iron, zinc, copper and manganese also increased with an increase in the temperature and period of fermentation. Improved HCl extractability of these minerals may partly be ascribed to the decreased content of phytic acid in the fermented blends as a significant negative correlation was found between the phytic acid and HCl extractability of minerals.

FCN-9 CONTENT OF PHYTIC ACID IN BLACKGRAM: CUMULATIVE EFFECT OF GERMINATION AND FERMENTATION

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Germination at 30°C for 48 h reduced the phytic acid content of blackgram significantly from 996.2 to 308 mg/100 g. Fermentation of blackgram sprouts at 30 and 35°C for 12, 18 and 24 h further diminished the level of phytic acid. The reduction in phytic acid content varied from 35 to 79 percent when different sprout slurries were fermented for varying periods at 30°C; whereas at 35°C, the loss ranged from 35 to 81 percent in different blackgram sprouts. Hence, germination followed by fermentation seemed to be more beneficial in removal of phytic acid from blackgram and may improve the digestibilities of starch and protein and bioavailability of minerals.

FCN-10 *WADI* FERMENTATION OF LEGUMES: DEVELOPMENT AND NUTRITIONAL EVALUATION

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Dehulled blackgram or greengram cotyledons are the basis of *Wadi* a legume fermented hollow, brittle, spicy, Japanese *miso* like product and is very popular in Indian households. For the preparation of *Wadi*, soaked greengram or blackgram *dhal* were coarsely ground and kept as such for fermentation at 35°C for 12 and 18 h, respectively. At the end of fermentation, salt (2 percent) and black pepper powder (0.65 percent) were added in the fermented slurry. Small portions were taken from this slurry and moulded in the form of *Wadies* (small round balls) with hand and dried at 60°C for 36 h. *Lactobacilli* were the dominating microflora followed by yeast, coliforms and fungi in the fermented slurry. Protein content of *Wadi* either decreased or remained unchanged, whereas the protein digestibility improved from 53.4 to 79.3 percent. Starch content was reduced drastically. Ash content did not change, whereas the fat content increased. *Wadi* fermentation decreased the phytic acid content. This nutritionally superior fermented product was organoleptically acceptable.

FCN-11 EXTRACTION OF SOYBEAN WITH HEXANE-ALCOHOL AZEOTROPIC SOLVENT: EFFECT ON BEANY FLAVOUR REMOVAL, PHYSICO-CHEMICAL AND FUNCTIONAL CHARACTERISTICS

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The number of industries based on soybean have been steadily increasing as a result of higher agricultural output of soybean in India. However, its utilisation in various food formulations has been limited due to the presence of bitter\beany flavours associated with it. In the present study, soy flakes were extracted with hexane-alcohol azeotropic solvent at 59°C for 2 h. The effect of extraction on the sensory, physico-chemical and functional characteristics of the meal were studied in comparison with that of hexane extracted meal. There was a reduction of 82 percent in the lipoxygenase activity followed by 72 percent reduction in beany flavour in the treated meal. Gel filtration and gel electrophoresis showed aggregation of the proteins in the treated meal. However, no significant changes were observed in water and fat absorption capacity, emulsification and foaming properties.

FCN-12 EFFECT OF ORGANOCHLORINE PESTICIDES ON PHYSIOLOGY OF MOULTING, SURVIVAL AND BIOCHEMICAL COMPONENTS OF THE INDIAN WHITE PRAWN, *(PENAEUS INDICUS* EDW.)

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India occupies seventh place among the leading countries in aquaculture, producing 1.6 million tonnes of sea food (fish and prawns). Unfortunately, such a worthy aquaculture enterprise is being affected by marine pollution in India. Recent studies have revealed the presence of high levels of HCH and DDT contamination in marine ecosystem of Indian coast. In the present investigation, the effect of sublethal concentrations of DDT (0.4 ppb), BHC (0.8 ppb) and their mixture (0.1 ppb 1:1 w/w) on moulting, survival and biochemical constituents of juvenile prawns, *Penaeus indicus* were studied for 90 days. The results showed that, moulting of prawns was unaffected upto 20 days in all pesticide exposures. However, growth was reduced (99.1, 53.54, 123.17 percent) and moulting period was increased (29.16, 38.0, 95.37 percent) significantly ($P < 0.01$) in treated prawns during 90 days of exposure. The survival rate decreased by 33.3 percent in the prawns exposed to mixture of DDT and BHC. Individual treatment of prawns with either DDT or BHC did not produce any mortality during experimental period. Proteins, free amino acids and total lipids were significantly

($P<0.05$) reduced in muscle, hepatopancreas and gills in the treated prawns. This study has clearly shown that sublethal concentrations of DDT and BHC affect biochemical constituents and also alter the growth and development of the prawn in long-term exposure. Further, the data indicate that pesticide contaminants are likely to alter the nutritional quality of marine food.

FCN-13 PURIFICATION AND CHARACTERIZATION OF RICE BRAN LIPASE

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In order to understand the mechanism of inactivation of lipase from rice bran by any of the physical or chemical methods, it is essential to isolate the enzyme in a homogeneous form. Earlier attempts in this respect both in this laboratory and elsewhere required procedures which used to take more than 48 h to get a reasonably pure lipase of relatively low activity. The present procedure adopted, reduces the time of isolation of lipase by nearly 36 h resulting in both, reasonably high activity and nearly three times more yield. The isolated rice bran lipase has been checked for the various physical and chemical properties and the results show that the enzyme has a pH optimum of 7.5; sedimentation coefficient of 2.30 ± 0.15 S; molecular weight of $30,000\pm1,000$, contains 10 percent alpha helix and 20 percent beta pleated structure in its secondary structure and was made up of two subunits of 15,000 molecular weight each. The enzyme was highly hydrophobic with an average hydrophobicity value of 950 ± 50 cal/residue.

FCN-14 DIET OF GIRLS' HOSTELS OF UDAIPUR CITY - MEAL PATTERN AND RESIDENTS' SATISFACTION

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The prime consideration of hostel food services like any other Institutional food service should be to provide adequate, wholesome and attractive food to the residents. The results of present survey undertaken in the girls' hostels of Udaipur city revealed that there was a marked difference in the food services provided by different hostels. Minimum of two meals (lunch & dinner) to four meals (breakfast, lunch, evening tea and dinner) were provided. The choice of food items prepared was markedly influenced by their seasonal availability in the local market. In lunch, usually *chapati*, *dhal*, one vegetable and rice were provided, whereas in dinner, *dhal* was replaced by curd and additionally salad was provided. On Sundays, special diet including a dessert was provided at lunch. Majority (80 percent) of residents were satisfied with the type of meals provided to them in view of the mess charges. However, an equal percentage (80 percent) of them were ready to pay increased mess charges to bring about an improvement in the diet. The improvement sought included more

quantity of serving of vegetables, curd, milk and salad. Also, 20-55 percent of them wanted frequent inclusion of eggs and fruits. Weekly inclusion of meat, ice cream and fruit juice was desired by a few (8 percent) residents.

FCN-15 SAFFLOWER SEED PROTEIN, CARMIN AND FLAVONOID INTERACTIONS

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Safflower seed contains a major protein fraction carmin which is isolated and characterized for its properties in this laboratory earlier. It also contains a number of flavonoids out of which the major one acacetin is isolated and characterized. The interaction between carmin and acacetin followed by the methods of batch gel filtration, fluorescence quenching and equilibrium dialysis suggest a maximum of two binding sites with an average association constant, K_a of $2.1 \pm 0.4 \times 10^4$ M^{-1} and a G^0 of -6.1 ± 0.2 kcal/mol. The results of effect of temperature suggests that the interaction is reversible and is driven by entropically dominated hydrophobic interaction. The prime residues involved in the interaction were identified as tryptophan and further confirmed by data from structural analogue of acacetin, namely biochanin A, the interaction of which suggested the involvement of methoxy phenyl ring confirming the stereospecificity of the ligand fitting into the binding site of the protein. The results from this would facilitate developing rationale for removal of the above undesirable factors from safflower seed meal.

FCN-16 EFFECT OF POLYOLS ON THE THERMAL STABILITY OF SESAME ALPHA-GLOBULIN

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Alpha globulin from *Sesamum indicum* coagulates upon heating. Interaction with polyols reduced the extent of coagulation to varying extents (percent) in sucrose, fructose, xylose, glucose and glycerol at 1M alpha-globulin upto 61 ± 2 43 ± 1, 21 ± 1, 13 ± 1 and 9 ± 2 percent, respectively. The thermal coagulation curves measured by controlled temperature increment vs absorbance showed that the midpoint of transition shifted from $78 \pm 2^\circ C$ for control to $87 \pm 2^\circ C$ in 30% glycerol. Measurement of spectral properties indicated a shift in the fluorescence emission maximum from 331 nm to 333 nm with a simultaneous increase in emission intensity upto 21 ± 1, 30 ± 1 and 34 ± 1 percent in presence of 10, 20 and 30 percent glycerol, respectively. The number of tyrosyl groups titrated reduced from 58 ± 2 in the control to 48 ± 2 in presence of 30 percent glycerol suggesting the molecule to be compact in presence of polyols. The mechanism of prevention of heat coagulation

thus involves changes in the conformation of alpha-globulin by polyols. These results can find an application in keeping the coagulable protein in solution under certain processing conditions in many foods.

FCN-17 EFFICIENCY OF INACTIVATION OF TRYPSIN INHIBITOR BY ROASTING OF SOYBEAN

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Trypsin inhibitor acitivity (TIA) in soy splits was considerably inactivated by roasting for different intervals of time and the extent of inactivation depended not only on the duration, but also on initial temperature of roasting. The batch size as well as mode of roasting had considerable influence on the TIA in the final product due to the pattern of heat transfer in the roaster. *In vitro* and *in vivo* studies showed that roasted soybean was free of TIA, upto a level of an average value of 95±2 percent of the TIA value of the starting material. This was also confirmed by *in vivo* results involving histopathology of weanling albino rats.

FCN-18 DEVELOPMENT OF GERIATRIC FORMULATIONS BASED ON MALTED WHEAT AND LEGUMES

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Three geriatric formulations based on malted wheat and legumes were prepared with special reference to the dietary bulk and nutritional quality of the blends. Conditions were optimised for the period of germination of the wheat and legumes for obtaining blends with high amylase activity and low dietary bulk on cooking. The protein contents of the formulations were around 16 percent. Rat feeding trials indicated that the blends were of high nutritional quality (PER: 2.3-2.6; TD: 95-95 percent; BV: 83-91 percent and NPU: 81-86 percent). The formulations were found suitable to prepare common recipes such as *chapati* and *phulka*.

FCN-19 EFFECT OF HOME SCALE PROCESSING ON THE AFLATOXIN B_1 CONTENT OF SELECTED FOODGRAINS

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The effect of home scale cooking processing on aflatoxin B_1 destruction has been carried out in selected foodgrains. Different food products such as *idli, dosa, muruku, chapati* and *poori* were made using selected food grains and destruction of the toxin was estimated at various stages of processing. All the cooking methods employed like roasting, boiling, steaming, frying, fermentation and baking showed positive in reducing aflatoxin content. The extent of destruction ranged from 12.5 to 86 percent in various cooked products. Roasting and fermentation resulted in highest destruction of the toxin.

FCN-20 FUNCTIONAL PROPERTIES OF HOMOGENEOUS PROTEIN FRACTIONS FROM GROUNDNUT (*ARACHIS HYPOGAEA L.*)

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Arachin (Ara) (71 percent), conarachin II (CII) (13 percent) and conarachin I (CI) (17 percent) are the major protein fractions of groundnut total proteins (TP). The surface properties of each phenomenon lies in the functional properties of total proteins. Hence, the functional properties of the isolated, homogeneous protein fractions of groundnut were evaluated to find out whether such properties were additive. The water absorption capacity of the protein fractions was in the order CI>CII>TP>Ara. The fat absorption capacity followed the order : CII>Ara>CI>TP. The foaming capacity was: TP>Ara$\geq$CI>CII and the emulsifying activity followed the order: TP>CI>CII>Ara. The foaming capacity values increased from 148 to 220, 128 to 190, 112 to 184 and 128 to 200 us/cm for TP, Ara, CII and CI, respectively after hydrolysis with alpha-chymotrypsin. Such information is highly potential for the use of protein fractions of groundnut in many food formulations.

FCN-21 REVERSIBLE COMPLEXATION OF POLYPHENOLS WITH HUMAN SERUM ALBUMIN

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The presence of polyphenols such as chlorogenic acid (CGA), caffeic acid (CA) and quinic acid (QA) is predominant in many food systems such as oil seeds, coffee, tea etc. These polyphenols

enter the blood stream. Human Serum Albumin (HSA) is a major carrier protein present in blood and known to bind a number of ligands. It is of interest to investigate the nature of interaction of CGA, CA and QA with HSA, effect of binding on the protein molecule and the reversibility of the complex formed. Fluorescence quenching, zonal gel filtration and equilibrium dialysis were used for the generation of interaction data with CGA & CA and showed K_a values of 1.36×10^3 M^{-1} and 4.18×10^4 M^{-1} and G^o value of -4.27 K.Cal/mol and -5.85 K.cal/mol, respectively. Temperature studies showed the involvement of aromatic residues in the entropically driven hydrophobic interaction, where CGA and CA binding destabilizes HSA. The reversibility results of CGA-HSA complex suggest that the entire process is reversible with no significant changes in structure and conformation of HSA. These results explain at a fundamental level the fate of polyphenols present in foods and blood proteins so that remedial measures can be taken to prevent excessive presence of polyphenols in food systems.

FCN-22 INTERACTION OF CHLOROGENIC ACID, CAFFEIC ACID AND QUINIC ACID WITH HELIANTHININ FROM SUNFLOWER SEEDS (*HELIANTHUS ANNUS* L.)

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Sunflower seeds contain polyphenols, such as chlorogenic acid (CGA), caffeic acid (CA) and quinic acid (QA). The protein from sunflower seed consists of a major fraction termed helianthinin to the extent of 60-65 percent and is shown to interact preferentially with polyphenols. The interaction was studied by fluorescence spectral titration at 28°C of helianthinin with : CGA resulting in K_a of 4.54×10^4 M^{-1} and QA resulting in K_a of 4.78×10^4 M^{-1} and CA resulting in K_a of 1.14×10^4 M^{-1} and with the equimolar mixture of CA + QA resulting in K_a of 1.08×10^4 M^{-1}. The analysis of results of binding of CGA by equilibrium dialysis and fluorescence spectral titration suggests 18 ± 2 ligand binding sites. Based on the above results, it is hypothesized that a combination of entropically driven hydrophobic interaction along with charge-transfer complexation with positive co-operativity between CGA and the protein is responsible for the process of binding of polyphenols to sunflower seed proteins. Based on this, one can prepare low CGA containing protein flours which can have a potential application in food formulations.

FCN-23 DOES PHYTIC ACID INTERACT WITH HUMAN HEMOGLOBIN ?

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It is of interest in this study to investigate whether phytic acid (PA) does interact with Human Hemoglobin (Hb) ? Investigation is carried out both at optimum pH of interaction at 3.2 and physiological pH at 7.4. From thermal denaturation studied at pH 3.2, Hb showed apparent transition

temperature (T_m) of 70±1°C with H^o 19.82 K.Cal/mol and S^o 58 e.u. In presence of 1mM PA concentration, T_m increases by 4°C with increased enthalpy and entropic values. At pH 7.4, Hb showed T_m of 54±1°C with H^o of 54 K.Cal/mol and S^o of 165 e.u. and upon PA binding T_m increases to 10°C at the concentration of 1 mM PA with H^o of 40 K.Cal/mol and S^o of 119 e.u. The results suggest that Hb is stabilized against denaturation upon interaction of PA *in vitro* with a pre-conformational change. Such process of binding may have an influence on the oxygen carrying capacity and other functional properties of protein which is currently under investigation. These results serve as a model for understanding the nature of interaction of phytic acid with seed proteins and facilitates in minimising process development in oilseed flours.

FCN-24 **BIOCHEMICAL CHANGES IN FENUGREEK SEEDS UNDER VARYING LEVELS OF IRRIGATION AND PHOSPHORUS**

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Fenugreek (*Trigonella foenum*-graecum) is used as spice, condiment medicine in Ayurvedic system and for lowering the cholestrol level in blood. Fenugreek Cv. Pusa Early Bunching was raised under four irrigation levels (112.5, 75, 56.25 and 45 mm, cumulative pan evaporation (CPE) and three levels of phosphorus fertilization (0, 20, 40, 60 Kg/ha). Protein content ranged from 20.4 to 24.85 percent and the highest protein content was observed with irrigations of 75 mm CPE and phosphorus application at 40 Kg/ha. Number of protein bands varied from 16 to 34 of varying Rf values 0.100 to 0.988. Linoleic acid ranged from 40.21 to 50.34 percent, while linolenic acid ranged from 19.49 to 25.48 percent. The order of fatty acids was found to be C 18:2 > C 18:3 > C 18:1 >C 16:0 > 18:0. Total unsaturated fatty acids ranged from 83.02 to 87.70 percent. Na and K ranged from 400 to 680 and 1080 to 1760 ppm, respectively.

FCN-25 **SALINITY AND SODICITY EFFECTS ON BIOCHEMICAL PARAMETERS OF CORIANDER FRUIT**

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Investigations were conducted to study the effects of different levels of salinity (control, 1.08, 4, 6, 8, 10 ds/m Ece) and sodicity (0, 5, 10, 15, 20 ESP), on biochemical and nutritional parameters of coriander fruit (*Coriandrum sativum* Cv. Pant). Protein content decreased from 3600 to 1480 ppm and NDF and ADF decreased with the increase of salinity, while NDF increased with sodicity. Cellulose content increased and hemicellulose content decreased under both types of environment.

Oleic and linolenic acids were found to be the major fatty acids. Wide variations in protein pattern and number of bands (8-14) were also observed.

FCN-26 INFLUENCE OF STRUCTURE STABILIZING SOLVENTS ON THE STRUCTURAL STABILITY OF ALPHA AMYLASE

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Alpha-amylase (1,4 alpha-D-glucan glucanohydrolase EC 3.2.1.1) from *Bacillus amyloliquefaciens* has an optimum temperature of activity between 50-70°C. It is of interest to stabilize such enzymes with very specific solvents which stabilize it by preferential hydration. Co-solvents like glycerol, sucrose and dimethyl sulfoxide (DMSO) are used for measuring partial specific volume of alpha amylase. The partial specific volume of the enzyme was measured both under isomolal (phi_{o2}) and isopotential (phi_{o2}) conditions. The phi_{o2} and phi_{o2} values in buffer were 0.723 and 0.745 ml/g, respectively. Among the co-solvents used, 20 percent glycerol, was found to stabilize more with a phi_{o2} and phi_{o2} values of 0.726 and 0.776 ml/g. The phi_{o2} and phi_{o2} values in 20 percent sucrose were 0.702 and 0.745 and in 25 percent DMSO, 0.713 and 0.744 ml/g respectively. From the values of preferential interaction parameters in these co-solvents, the structural stability of the enzyme has been evaluated.

FCN-27 EFFECT OF STORAGE TIME AND TEMPERATURE ON FORMATION OF RESISTANT STARCH IN SELECTED FOOD ITEMS

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Heat processed food products were stored at 27°C (0 h and 12 h) and 4°C (12 h and 24 h) and resistant starch (RS) formed in them was estimated. On dry weight basis, the percent RS formed in freshly cooked samples were 6.06 in rice, 2.79 in *chapati*, 6.61 in potatoes, 8.77 in Bengalgram *dhal*, 10.03 in greengram *dhal* and 5.79 in redgram *dhal*. On storing the samples for 12 h (27°C), the percent increase observed was 155.1 for potatoes, 134.8 for rice, 112-113 for *dhals* and 106 for *chapatis*. At 4°C (12 h) a significant increase was seen in rice, potatoes and Bengalgram *dhal*. On increasing the storage time (24 h, 4°C) rice and *chapati* showed an increase, whereas remaining food samples showed a decreasing trend. A distinct difference in the behaviour pattern of starch was observed depending upon the source of starch such as cereals, tubers or legumes.

FCN-28 RICE BRAN PROTEINS : CHARACTERIZATION AND *IN VITRO* ENZYME HYDROLYSIS

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Freeze-dried protein concentrates from untreated, acid stabilized, heat stabilized and parboiled rice bran were characterized for various physico-chemical properties and investigated for *in vitro* proteolysis. The results show an increase in low molecular weight proteins in stabilized rice bran proteins. Acid stabilization and heat treatment causes a blue shift in ultraviolet spectrum of rice bran proteins. The proteins undergo a red shift in fluorescence emission maxima upon both acid and heat treatment as compared to control untreated sample. *In vitro* enzyme hydrolysis with alpha-chymotrypsin ranged from 7-25 percent for different samples. Trypsin hydrolyzed heat treated rice bran samples to a greater extent of 33 and 50 percent, whereas untreated and acid stabilized samples showed hydrolysis of 20 and 23 percent, respectively. Pepsin hydrolysis was highest for acid stabilized rice bran protein concentrate (45 percent) followed by parboiled (25 percent), untreated (20 percent) and heat stabilized samples (9 percent).

FCN-29 ACCEPTABILITY TRIALS ON INDIAN PAPADS INCORPORATING RICE BRAN

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Acceptability trials were conducted for papads made by incorporating different levels of defatted rice bran (5, 10, 20 and 30 percent) to rice flour and sago flour. They were evaluated for colour, texture and flavour by a group of 20 trained panel members. The scores obtained for different products were statistically analyzed. The mean scores obtained were high for controls and decreased progressively with an increase in the amount of rice bran added. The overall quality of product exhibited an influence of colour and texture and the products were rated accordingly. Analysis of variance revealed highly significant differences in quality parameters of different products. Products with smaller level of rice bran incorporation (5-10 percent) were termed as acceptable by panel members.

FCN-30 FORTIFIED SALT: DOES IT ALTER SENSORY ATTRIBUTES, STORAGE QUALITY AND BIOAVAILABLE IRON OF *CHUTNEYS* AND PICKLES ?

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A survey of 60 families revealed that 60 percent of the families used crystal salt, 26 percent of them used table salt and 14 percent used fortified salt for various food preparations. Two *chutneys* (tamarind and tamato) and two pickles (amla and lime) were selected as food items. Four types of salts namely crystal salt, table salt, iodized salt and iron fortified salt were used for each preparation of *chutneys* and pickles. *Chutney* and pickle samples were stored in glass jars for 8 weeks in room temperature. The samples were analysed for their sensory attributes at weekly and fortnightly intervals. Rank order method was utilized to evaluate the sensory attributes. Bioavailable iron was analysed in all the samples at initial and final stages of storage.

Kramer's analysis of the findings on sensory attributes revealed no significant differences between the samples of *chutneys* and pickles in all the sensory attributes namely colour, odour, texture and flavour. However, metallic flavour was present in all the samples in the initial stages of storage. Amla pickle with iron fortified salt showed blackish grey colour after 4 weeks of storage. All salt variations in the pickles showed highest percentage of desirable quality after one month of storage. All the samples with iron fortified salt contained high percentage of bioavailable iron and all the samples showed low percentage of decrease in the bioavailable iron due to storage. It may be postulated that use of fortified salt does not alter sensory attributes, except iron fortified salt which gives slight metallic flavour in all the samples and colour in amla pickle.

FCN-31 A GLOBAL METHOD TO ESTIMATE THERMO-PHYSICAL PROPERTIES OF LIQUID FOODS FROM LITERATURE DATA

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Theoretical expressions were developed from first principles for the thermo-physical properties of liquid foods and for those of the dry materials. From the properties of pure water as the functions of temperature fitted by adequate regression equations, and the literature values of density, specific heat, thermal conductivity and thermal diffusivity at specified temperatures and moisture contents, it was possible to estimate these properties at any given temperature and moisture using the basic expressions developed here. It is going to be a very useful method eliminating experimental determination of these properties which besides being time consuming and error prone also needs the specific apparatus that may not always be available.

FCN-32 COMPARATIVE STUDY OF MAJOR CARBOHYDRATE COMPONENTS IN SOME COMMON FOODS

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The aim of the present study was to compare the quality of carbohydrates present in potato and parbolied rice, in order to find the suitability to feed a diabetic patient. For this, raw boiled and cooked potato and parboiled rice were used and the various parameters such as dry matter, starch and soluble carbohydrates were determined. Various foods were then fed to rats and the digestibility and growth studies indicated that there was no significant difference with respect to digestiblity coefficient and growth. On the basis of total digestible major carbohydrate content, the amount of 75 g. paraboiled rice is comparable to 500 g of boiled potatoes. The study indicated that boiled potato could equally be given to a diabetic patient like that of parboiled rice.

FCN-33 STUDIES ON INCLUSION COMPOUNDS OF BETA-CYCLODEXTRIN IN FOOD RESEARCH

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Cyclodextrins are cyclic oligosaccharides which possess the unusual property of forming inclusion complexes with a wide variety of guest molecules many of which find applications in food and drug industry. A detailed study of the inclusion complexes of Beta-cyclodextrin was carried out in order to explore their uses in food applications. This will include structural studies of inclusion complexes of some guest molecules with Beta-cyclodextrin, the use of Beta-cyclodextrin and some of its derivatives as catalysts in some organic transformations like autooxidation of benzoin, formylation of some substituted phenols and oxidation of cyclic secondary alcohols, resolution of racemic mixtures and removal of caffeine.

FCN-34 REGIO-, STEREO- AND CHEMO-SELECTIVE ORGANIC SYNTHESIS USING BETA- CYCLODEXTRIN

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It has now been well established that Beta-cyclodextrin (BCD) mimics enzyme action by carrying out regio-, stereo- and chemo- selective organic transformations. Possibility of performing

a wide range of reactions with high selectivity/specificity at a faster rate, under mild reaction conditions are the most attractive aspects of BCD reactions. We have used BCD and its derivatives as novel hosts in the following reactions and studied their interaction with guest molecules, which determine the selectivity of the product formed. The hydroxymethylation of guaiacol in the presence of BCD and its derivatives showed a high regio-selectivity towards the isovanillyl alcohol formation. High stereo- and enantio-selectivities were observed in the sodium dithionite reduction of menthone with BCD, favouring (-) menthol formation. High chemo-selectivity was observed in the sodium dithionite reduction of cinnamaldehyde with BCD, favouring the cinnamyl alcohol formation. The results obtained in the above reactions will be discussed in detail.

FCN-35 HYPOXIA AND GUSTATORY RESPONSES IN RATS

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One of the complaints of high altitude (HA) sojourners is loss of appetite/hypophagia. In the present study, the rat was taken as an animal model to investigate the pathophysiology underlying the problem of hypophagia at HA. The rats were exposed to a simulated HA of 7620 m for 6 h daily and continuously for 21 days. Their feeding behaviour and gustatory responses were observed before, during and after exposure to HA. Their 24 h food and water intake and body weight were recorded daily and blood samples drawn weekly for blood sugar analysis. Saccharine (0.2 percent), glucose (13 percent), sodium chloride (0.9 percent), citric acid (0.16 percent), quinine sulphate (0.001 percent) and tap water were presented as taste stimuli in single- bottle 1 h test to find out the changes in gustatory responses. The results showed a decrease in 24 h food and water intake and body weight. Blood sugar reflected a state of mild hyperglycemia and gustatory responses showed an increased intake of glucose and saccharine solutions during hypoxic exposure period. It appeared that changes during hypoxic stress were within range of physiological variation as the rats showed a tendency to come back to pre-stress levels, after termination of hypoxia.

FCN-36 PALM OIL: RELATIONSHIP OF SENSORY QUALITY WITH PHYSICO-CHEMICAL MEASURES AND OPTIMISATION OF KREIS TEST

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Among the several physico-chemical tests tried in palm oil, Kreis test has shown better correlation with sensorily perceived rancidity in early stages ($r = 0.77$), followed by peroxide value of 0.75. Kreis test has the advantage of indicating the breakdown products, specifically aldehydes,

while peroxide value runs into the risk of giving false low values during continued storage. Kreis test is less subjective when the developed colour is measured spectrophotometrically than matched using a tintometer. Being a continuous colour developing reaction, it was necessary to study the kinetics of the colour development. In the present study, the reaction was studied as a function of three factors viz., oil, reagent and incubation time, at five levels of each, using central composite rotatable design (CCRD). Polynomials of appropriate degrees were fitted and using flexible polyhedron search method, optimum conditions were identified. 3- D graphs were used to trace the interactions and the kinetics to visualise the ideal conditions of the test. Suitable recommendations have been suggested for carrying out the test in palm oil.

FCN-37 EFFECT OF METAL IONS ON THE FORMATION OF NITROGEN HETERO-CYCLIC COMPOUNDS PYRAZINES AND PYRIDINES IN SAFFLOWER (*CARTHAMUS TINCTORIUS*) SEED OIL-O(-AMINO ACIDS MODEL SYSTEMS UNDER FRYING CONDITIONS

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The aroma and flavour of deep-fat-fried foods immensely depends on the composition of metal containers in which food is fried. The formation of pyrazines and pyridines in safflower seed oil (Saffola) and alpha-amino acids model systems with and without metallic ions such as Fe, Cu, Al and Sn heated under frying conditions are reported. Neutral amino acids viz., glycine, DL- alanine and L-beta-phenylalanine each 20 g and safflower oil (400 g) were heated at 185$\pm$5^{o}C for 5 h. From the reaction mixture, basic fraction was separated, pyrazines and pyridines were isolated by TLC. These were identified and characterized by UV, I.R, GC and GC-MS. Saffalo-glycine gave 2-methyl pyrazine; 2,6- dimethyl pyrazine and 2-acetyl pyridine. With Cu system, 2- ethyl-3-methyl pyrazine and 2-methoxy-3-isobutyl pyrazine were characterized in addition to the compounds listed in blank system. With Al and Sn systems, 2-methylpyrazine; 2,6-dimethyl pyrazine and 2-acetylpiradine were identified. Saffalo-alanine- Fe gave 2-methylpyrazine; 2-ethyl-3-methylpyrazine; 2-methoxy-3-isobutyl pyrazine; 2-acetyl pyridine and 2-n-pentyl pyridine. In case of Cu, tetramethyl pyrazine was characterized in addition to the compounds listed in Fe system. Three pyrazines and one pyridine were identified in Saffalo-phenylalanine system. In the case of Cu, 3-methoxy-2-isopropyl pyrazine and tetramethyl pyrazine were identified in addition to the compounds listed in blank system. The total quantity and number of pyrazines formed was largest in the presence of Cu, followed by Fe and Al. In the presence of Sn, concentrations of pyrazines were least suggesting the inhibitory role of Sn in the generation of pyrazines. The study indicated the interaction of metal ions in the formation of flavours in fried foods.

FCN-38 CHANGES IN RAT HEPATIC GLUTATHIONE LEVEL INDUCED BY PROCESSED AND RAW CABBAGE

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Since cooking reportedly reduces the levels of glucosinolates to about 40 percent in cabbage, the cooked and dehydrated vegetable was administered at 20 percent (w/w) to male rats, so as to investigate the changes, if any, in the enzymes involved in glutathione (GSH) turnover in liver. No marked changes in the food intake, weight gain and relative liver weights were observed in the group of animals, after 10 days of exposure to the experimental diet, as compared to control diet. A significant increase in hepatic glutathione reductase activity observed in the cabbage diet group suggests possible increased demand of GSH under the conditions of exposure. Hepatic GSH-S-transferase activity was increased significantly, whereas GSH-peroxidase activity was not changed. Effect of glucosinolates hydrolysed either *in situ* or enzymatically using myrosinase on liver GSH pool will be discussed.

FCN-39 CULTIVATION OF YACON AND THE STUDY OF FRUCTANS IN THE TUMBER

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Yacon (*Polymnia sonchifolia*) is a perennial vegetable of the compositae, originally found in the Andean highlands in Southern America. Only a few local people cultivated it and ate the raw tuberous roots. With luxuriant leaf vegetation, Yacon also shows prolific growth of edible tuberous roots and seed roots, weighing in total about 5 kg for each plant. In experimental cultivation in Japan, they were cropped at 50 ton/ha. Plants grew well even in rather poor land, with their only susceptibility being an aversion to excessively hot weather. The most remarkable characteristic of these edible roots is that they contain a large amount of oligofructans (about 70-80 percent of dry matter). Since oligofructans are proved to be useful in modulating the intestinal flora of humans as well as animals, and in preventing hyperlipidemia, the cultivation, cropping and extraction of Yacon roots will be a very valuable area of farming in tropical highlands.

FCN-40 VARIETAL AND LOCATION EFFECTS ON QUALITY OF SOYBEAN (*GLYCINE MAX.*)

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Varieties of 5 improved yellow soybean and 1 of indigenous black soybean were grown in four different locations of Madhya Pradesh. The samples collected from each location were analysed for

various quality parameters like test seed weight, *dhal* and hull percentages, moisture, protein, fat and total polysaccharides, cooking time, limiting amino acids, tryptophan and methionine and antinutritional factors, trypsin inhibitor activity and phytic acid contents. All were affected by varietal differences. The statistical analysis showed highly significant variations in the varietal vs location interactions in all the above quality parameters.

FCN-41 EFFECT OF SALTS ON CORN STARCH-GUAR GUM COMBINATIONS

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Starch-gum interactions have been used for the past many years in food product development. In any food product, these combinations always co-exist with other ingredients like sugars and salts and are expected to influence the functionalities of the starch ingredient. In the present work, an attempt was made to study the effect of various inorganic salts like sodium chloride, sodium phosphate, sodium sulphate, potassium chloride and calcium chloride on corn starch-guar gum combinations. The results were interpreted with respect to the changes in gelatinization temperature and cold paste viscosity. In the case of starch alone, there was an increase in cold paste viscosity and gelatinization temperature in the presence of salts. But such a direct behaviour was not seen in the presence of guar gum. The possible mechanisms are suggested to interpret the behaviour of starch-guar gum combinations in the presence of salts. Based on these results, possible applications in food product are suggested.

FCN-42 EFFECT OF PROCESSING ON ANTINUTRIENT CONTENTS OF SOME GREEN LEAFY VEGETABLES

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The present investigation was undertaken to study the effect of processing on antinutrients viz., oxalic acid, phytic acid and polyphenol contents in leaves of bathua (*Chenopodium album*), cholai (*Amaranthus tricolor*), fenugreek (*Trigonella foenum-graecum*) and spinach (*Spinacia oleracia*). Different processing treatments like storage (24 and 48 h in refrigerator in two packings, and 24 and 48 h at 30°C in polythene packing), blanching (5, 10 and 15 min in equal volume of water), and cooking (open pan and pressure cooking) were studied. On dry weight basis, oxalic acid (g/100 g), phytic acid (mg/100 g) and polyphenol (mg/100 g) contents of fresh leaves varied from 0.91 to 14.92, 156.83 to 234.50 and 11.96 to 22.88; in blanched leaves, they varied from 0.45 to 8.38, 125.87 to 231.33 and 9.08 to 19.71; and leaves cooked in open pan and pressure cooker varied from 0.57 to 8.85, 129.43 to 234.36 and 11.38 to 22.27, respectively. Non-significant differences

were found in antinutrient contents of the stored and fresh leaves. Significant reduction of these antinutrients was observed in the blanched leaves. Oxalic acid content of cooked leaves was significantly lower than fresh leaves, while non-significant differences were observed in phytic acid and polyphenol contents of cooked and fresh leaves. The study indicated that, blanching and cooking help in reduction of oxalic acid.

FCN-43 EFFECT OF PROCESSING ON IRON CONTENT AND ITS AVAILABILITY (*IN VITRO*) IN SOME GREEN LEAFY VEGETABLES

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A study was conducted to determine the effect of cooking (open pan and pressure cooking) and blanching (5, 10 and 15 min. in equal volume of water) on total iron content and its availability (*in vitro*) in leaves of bathua (*Chenopodium album*), cholai (*Amaranthus tricolor*), fenugreek (*Trigonella foenum-graecum*) and spinach (*Spinacia oleracia*). Total iron content (mg/100 g) and its availability (*in vitro*) percent of total iron, varied from 20.63 to 24.14 and 2.79 to 4.16, respectively. Iron content in blanched, open pan and pressure cooked leaves varied from 9.81 to 27.33, 15.56 to 26.59 and 15.52 to 26.43 and their availability (*in vitro*) varied from 3.41 to 4.89, 4.09 to 5.02 and 4.12 to 5.04, on dry weight basis, respectively. Blanching of leaves for all the different time periods reduced the iron content significantly. The reduction in iron content increased with increase in period of blanching. Cooked leaves had significantly lower iron content irrespective of open pan and pressure cooking. Blanching for 15 min. and cooking in open pan and pressure cooker resulted in significant increase in iron availability (*in vitro*). The study indicated that, cooking irrespective of open pan or pressure cooking improved the iron availability (*in vitro*).

FCN-44 MODIFICATION OF TRYPTOPHAN RESIDUES OF LIPOXYGENASE L1 FROM SOYBEANS (*GLYCINE MAX*): EFFECT ON STRUCTURE AND STABILITY

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Lipoxygenase (LOXI) from soybean (*Glycine max*) contains 13 tryptophan residues. The accessibility of tryptophan residues was monitored by modification with N-bromosuccinamide and fluorescence quenching measurements with potassium iodide and acrylamide. Under non-denaturing conditions, the accessibility of tryptophan residues was pH dependent, at pH optimum of enzyme activity (pH 9.0), only one tryptophan residue was accessible, with the decrease in pH from 9 to 2, the accessibility increased. At pH 2.0 and 10 M urea, 11 tryptophan residues were modified. Under non-denaturing conditions at pH 9.0, the modification of one tryptophan residue resulted in partial loss of activity, enhanced the kinetic lag of oxidation of linoleic acid and decreased

the thermal stability without any detected structural changes in secondary structure of enzyme. The kinetics of the oxidation of tryptophan residues was biphasic in nature, with an initial fast reaction (sec.) followed by a slow reaction (min). Based on substrate binding studies with native and modified enzyme, it was inferred that, surface exposed tryptophans may not be involved in substrate binding.

FCN-45 A SOFTWARE FOR DIETARY COMPUTATIONS

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There are numerous quantitative models used by practitioners to evaluate the dietary intakes and nutritive values in humans. The ever changing socio-dynamics and growth of processed food items in the market have brought drastic changes in the food habits which in turn have neccessitated the need for computerised data bank for the efficient dietary related studies. An interactive package was made using Dbase IV on a personal computer. The package can compute the total nutritive value for varied food intakes and it could formulate dietary intakes given various input parameters. Besides, a comparative study can be made between dietary intake and recommended dietary intake (RDI). It supports updating of database, SQL-embedded query sessions and the generation of summary reports.

FCN-46 *IN VITRO* DIGESTIBILITY OF PROTEINS IN BLACKGRAM AND GREENGRAM *DHAL PAPADS*

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Papads were prepared with blackgram and greengram dhal flours and toasted, microwaved or deep-fat-fried. Toasting was done by holding the *papads* over direct flame for 1-2 min. For microwaving, Sharp Carousal microwave oven was used with automatic timer and setting at high temperature for 30-40 sec. Deep-fat-frying was done by immersing the product in pre-heated refined groundnut oil for 5-10 sec. *In vitro* digestibility of proteins in prepared *papads* was investigated using pepsin and pancreatin. The percent protein hydrolysed in blackgram *dhal papads* was 80.5, 75.3 and 72.5 for toasted, microwaved and fried *papads*, respectively. They were not significantly different from each other. Greengram *dhal papads* exhibited significantly higher hydrolysis in microwaved product (79.3 percent), when compared to toasted (65.2 percent) or fried products (65.0 percent).

FCN-47 STARCH DIGESTIBILITY (*IN VITRO*) IN RAGI-BASED PREPARATIONS

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Considering the carbohydrate contents of cereals, it is presumed their digestibility and glycemic responses would be almost similar. Despite this fact, it has been the general practice to recommend only ragi and wheat for diabetics. Hence, the present study was undertaken to determine the *in vitro* rate of starch hydrolysis in ragi preparations (with/without accompaniment) that are commonly used in South India. The results of the study revealed that, the total concentration of sugars released in these preparations - *roti, dosai, dumpling* and *puttu* using ragi and other cereals for comparison was affected by the method of preparation and accompaniments, viz., "*chutney*", "*sambar*", rather than the cereal base. Also, the rate of starch hydrolysis was similar in all the preparations, irrespective of cereal used. Digestibility index (DI) of ragi preparations was higher than wheat, but similar to rice and jowar controls. Scanning electron micrographs (SEM) showed complete disintegration of starch granule in dumplings and correlated with 100 percent gelatinization observed in this preparation. Therefore, ragi as a specific cereal for therapeutic use in diabetics has no beneficial effect over other cereals.

FCN-48 HYPOLIPIDEMIC EFFECT OF CORNBRAN AND BLACKGRAM SEED COAT IN HYPERCHOLESTEROLEMIC RATS

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Hypolipidemic effect of dietary fibre from cornbran and blackgram seed coat in hypercholesterolemic rats was studied. Thirty two rats were first made hypercholesterolemic by feeding one percent cholesterol supplemented basal diet for 6 weeks and then divided into 4 groups, and fed for another 6 weeks with diets having cornbran and blackgram seed coat as the source of dietary fibre at 10 percent level. Cellulose was the source of dietary fibre in control groups. As compared to the control group, a reduction of 19.29, 21.76 and 42.82 percent was observed in serum total lipids, cholesterol and triglycerides in rats fed cornbran, whereas blackgram seed coat produced 8.67, 10.82 and 24.73 percent reduction in serum total lipids, cholesterol and triglycerides, respectively. HDL-cholesterol significantly ($P<0.05$) increased with both the fibres. Liver total lipids, cholesterol and triglycerides were also significantly ($P<0.05$) reduced on feeding cornbran and black gram seed coat supplemented diets for 6 weeks. Hypocholesterolemic effect operated through increased faecal cholesterol and bile acids excretion. Among the fibre sources, cornbran had better hypolipidemic effect than black gram seed coat. Hence, the inclusion of the cereal brans and legume seed coats in the diet for preventive as well as therapeutic measures against coronary heart disease and the related ailments can be widely proposed.

FCN-49 LIPASE CATALYSED SYNTHESIS OF ISOAMYL BUTYRATE

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Natural isoamyl butyrate (IAB) is a flavour compound of fruits and is used as a supplement in food industries. The preparation of isoamyl butyrate was carried out by esterification of isoamyl alcohol and butyric acid using lipase from *Mucor miehei* immobilised on a macroporous anion exchange resin (Lipozyme IM). The effect of various process parameters (temperature, time of incubation and solvents) and substrate concentration were investigated to determine optimum conditions for the esterification process. The highest conversion of IAB (96 percent w/w) was obtained at 55°C and at 40 h of the reaction time. The optimum ratio of IAA:BA for maximum conversion was found to be 2:1. The concentrations of substrates and products as well as solvent were determined by gas chromatography. This shows that esterification can be modelled successfully by changing reaction parameters.

FCN-50 THE EFFECT OF SOIL GERMINATED FRESH WHEAT SEEDLING ON THE GROWTH PATTERN AND MINERAL STATUS OF WEANLING RAT

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The effect of 5 day old fresh wheat seedling was studied on the growth pattern of weanling rats. Fresh wheat seedling was fed to rats at 25, 50, 75 and 100 percent levels along with raw wheat flour. Hundred percent raw wheat flour served as control. As compared to raw wheat, fresh wheat seedling extract showed an increase in protein, calcium, phosphorus and iron by 66.6, 218.25, 65 and 58.1 percent, respectively. There was an increase in vitamins like B-carotene and niacin. Although ascorbic acid was initially zero, after soil germination it was 44.78 mg percent. Maximum gain in weight was observed with 50 percent level of fresh wheat seedling plus raw wheat flour feeding. Liver protein storage was increased upto 50 percent level of supplementation. Maximum liver niacin level was observed in rats fed with 100 percent fresh wheat seedling. Only increase in liver iron was observed in group fed with 50 percent fresh wheat seedling supplementation. In the bone, calcium and phosphorus levels increased, as the supplementation increased upto 75 percent level. In the weanling rats, it was observed that feeding with 50 percent level of fresh wheat seedling with raw wheat flour promoted better growth as well as storage of nutrients in the liver.

FCN-51 **EFFECTS OF HYDROXYPROPYLATION ON THERMAL AND FREEZE-THAW PROPERTIES OF BENGALGRAM STARCH**

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Retrogradation of starch can be prevented by derivatising it with hydroxypropyl ester groups. Hydroxypropylation of Bengalgram starch was done and starches of different molar substitution (M.S.) were prepared (M.S.). Hydroxypropylation improved the freeze-thaw stability of native Bengalgram starch. Native starch showed 48 percent water separation after 8 freeze-thaw cycles, while hydroxypropylated starches of 0.05, 0.06, 0.07, 0.08 and 0.1 M.S. showed 35, 18, 3, 2 and 1 percent water separation, respectively, after the same number of cycles. It was found that the viscosity of starch pastes increased as M.S. increased. The gelatinization temperature decreased by 10, 13, 15, 17 and 20°C for hydroxypropylated starch of M.S. 0.05, 0.06, 0.07, 0.08, and 0.1, respectively, as compared to native starch. However, the desirable properties of the native starch viz., high acid stability, high thermal stability and high shear stability were fairly unchanged.

FCN-52 **DETERMINATION OF DIETARY FIBRE CONTENT OF CEREALS AND CEREAL-BASED PREPARED FOODS BY TWO METHODS - ENZYMATIC VS. NDF METHOD**

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Dietary fibre measurements are essential for assessing the potential therapeutic and preventive effects of fibre intake. The content, total dietary fibre (DF), measured as the sum of water-insoluble (IDF) and water-soluble (SDF) fractions, was evaluated in 4 cereals and 10 cereal-based prepared foods. The DF content determined using the AOAC enzymatic-gravimetric method was compared with neutral-detergent fibre (NDF) method. The total DF content by the enzymatic method, ranged from 6.0 to 11.2 g/50 g carbohydrate portion for the cereals and 6.2 to 13.6 g/50 g carbohydrate portion for the prepared foods. Sixty to ninety percent of the IDF assayed enzymatically could be estimated by NDF method in cereals and 45-90 percent in the prepared foods. IDF values as measured by the enzymatic method were significantly higher than the NDF values. Soluble-fibre content as percentage of total DF averaged to 8 percent for cereals and 19 percent for prepared foods.

FCN-53 CARBOHYDRATE METABOLISM IN RIPENING BANANA FRUIT

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In order to determine the most dominant factor contributing to fruit softening in banana, the soluble/insoluble carbohydrates and the carbohydrate hydrolases were monitored during ripening. The insoluble carbohydrates were fractionated into 7 fractions based on their differential solubility patterns, and their profiles followed, before and after hydrolysis. The starch and pectin fractions decreased considerably in ripe banana pulp. The significant decrease in glucose concentration in the cold water soluble polysaccharides and that of xylose in the hemicellulosic fraction indicated a pronounced glucan and xylan degradation during ripening. The activity of various carbohydrate hydrolases viz., polygalacturonase, pectin methyl esterase, xylanase, glucanase, alpha-mannosidase, beta-galactosidase, amylase, cellulase and hemicellulase registered a general increase in their activities. More than 80 percent of the radioactivity of ^{14}C starch was found incorporated into soluble sugars: glucose, fructose and sucrose indicating sugar interconversions. Gluconeogenesis from ^{14}C aspartate and ^{14}C malate was also evident during the course of ripening. It appeared that pectinases may play a more dominant role in textural softening than cellulase/hemicellulase in banana. Amylase, xylanase and laminarinase may also contribute to loosening of cellular structure. Softening phenomenon, which needs to be regulated has a direct implication on fruit shelf-life.

FCN-54 LEVELS OF ANTINUTRIENTS IN HOME MADE READY-TO-EAT SUPPLEMENT MIXES AS AFFECTED BY DOMESTIC PROCESSING

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Four supplements using whole wheat, pearl millet, Bengalgram and greengram, groundnuts and amaranth leaves were developed employing home processing methods of roasting and malting. Domestic processing had a significant ($P<0.05$) effect on lowering phytic acid, polyphenols, and saponin contents of developed supplements which ranged from 320.0 to 350.3, 168.5 to 270.5, 950.7 to 1210.0 mg percent, respectively. The percent reduction in phytic acid, polyphenol and saponin contents of developed supplements due to processing varied from 41.6 to 54.9, 43.5 to 50.1 and 40.0 to 47.6, respectively. Lower concentrations of these factors in the developed supplements may be due to leaching of these antinutritional factors in water during soaking, enzymatic hydrolysis and denaturation of protein during malting and roasting. The protein digestibility (*in vitro*) of developed

(processed) supplements was found to be significantly ($P<0.05$) higher than that of raw (unprocessed) supplements. The improved protein digestibility of processed supplements might be due to reduction in antinutritional factors and also due to catabolization of storage protein during roasting and malting.

FCN-55 NUTRITIONAL IMPROVEMENT OF TRADITIONAL FOODS OF RURAL PEOPLE OF HARYANA

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A survey was conducted to get the information about the commom traditional foods of rural Haryana. These cereal and pulse-based products have been found to be deficient in one or more essential nutrients. These products were then prepared in combination with green leafy vegetables, roots tubers, pulses and oilseeds, to enhance the nutritional qualities of diets of people using indigenous technological methods. The recipes were developed, standardized and nutritionally evaluated. *Moranda* contained maximum amount of energy (1394 Kcal/100 g) and protein (29.2 g/100 g) among the cereal-based recipes and *Spinach dhal Pakora* among legume-based ones (884 Kcal calories and 25 g protein/100 g). Calcium and iron contents varied from 29 to 129 mg percent and 3.0 to 21 mg percent in cereal recipes and from 33 to 182 mg percent and 4.0 to 18 mg percent in pulse-based ones. *Spinach dhal Pakora* also contained a substantial amount of beta-carotehe.

FCN-56 PREPARATION AND QUALITIES OF WEANING FOOD

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Locally available raw materials were used to prepare an acceptable and nutritious weaning food. Four recipe combinations used in this study were compared with "*CERELAC*" (control), for sensory quality, viscosity, physico-chemical and nutritional qualities. The product prepared by combining soybean treated with 0.5 percent sodium bicarbonate, malted sorghum, tapioca flour, greengram *dhal* flour and skimmed milk powder was adjudged as best considering sensory qualities. Cold slurry and hot paste viscosity were found to decrease significantly at all shear rates of the selected product. It will enable the child to consume more and increase the nutrient intake. There was an increase in the dispersibility with non-significant effect on bulk density. The proximate composition fulfilled the minimum requirements. There was an increase in *in vitro* protein as well as starch digestibility with no antitrypsin activity. The energy value was 384.65 Kcal per 100 g of the product.

FCN-57 DEVELOPMENT OF WEANING FOOD BY UTILIZING LOCALLY AVAILABLE RAW MATERIALS

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In an effort to develop a weaning food based on two prime ingredients available in Himachal Pradesh viz., apple and potato, it was found that mashing the boiled, peeled and cored apples and potatoes and supplementing with other minor ingredients, a weaning substitute was possible at the household scale in a dry/powder form. The product was of low cost and conformed to the recommended daily allowances (RDAs) as suggested by Indian Council of Medical Research (ICMR).

FCN-58 BIOCHEMICAL EVALUATION OF VEGETABLE COLOCASIA OF HIMACHAL PRADESH

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Colocasia, because of its capability of growing under varied range of climatic conditions, is grown for being used as vegetable in almost all parts of Himachal Pradesh. The versatility of this plant is reflected by the fact that not only the rhizome, but also the stem and leaves are used as vegetable in Himachal diets. In spite of this, there is no recommended variety of *Colocasia* with quality characteristics. In an effort to develop variety of *Colocasia* having good quality with respect to its dietary constituents, a collection of the tubers was made from 3 different regions of Himachal Pradesh and subjected to analysis. It was found that carbohydrates constitute the major source of dietary energy in all the samples. Fat content was about 0.45 percent and protein content about 1.4 percent, in the edible portion of tuber. All samples were fairly rich in magnesium, potassium and calcium. The samples collected from different regions have been grown at Palampur in the experimental farm of the University under similar environmental conditions. Further analysis of various parameters in leaves, stem and tubers is in progress.

FCN-59 BIOCHEMICAL AND MOLECULAR FINGERPRINTING OF COMMERCIALLY RELEASED INDIAN WHEAT VARIETIES FOR IMPROVING QUALITY STANDARD

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Wheat is the only grain that can be made into a dough that rises and produces light, fluffy baked food items. Wheat's most important dough making components are its proteins. Hundreds

of new wheat varieties enter national and international commodities market every year. Cross-breeding of hard and soft wheats has produced new varieties that no longer conform to the traditional standards. The need for determining or verifying the identity of grain samples with respect to variety arises at all stages of grain production from seed certification to milling. Tests of identity involving nutritional quality, organoleptic and procesing qualities are not as meaningful as biochemical and molecular tests. In practice, however, it often cannot be assumed that a sample is homogeneous with respect to variety. For this, a strategy was developed for half-seed analysis of the three seed storage protein classes including triticin, gliadin and glutenin. The results will be presented in the form of a key for the identification of these varieties based on their seed protein composition. More recently, wheat breeders are using parts of a rye chromosome that produces rye protein secalins, to enhance wheat yield and confer resistance to stem, leaf and yellow rusts, powdery mildew and greenbugs. However, secalins account for the poor mixing and baking characteristics of flours from wheats carrying 1RS. The varieties were analysed for the presence of rye chromatin using a rye-specific repetitive DNA probe and two of the recently released varieties were found to possess the rye chromatin. The data obtained from these experiments will help breeders develop varieties with improved processing quality.

FCN-60 DIETARY FIBRE: HOW MUCH DO VEGETABLE PROVIDE TO OUR DIET ?

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Dietary fibre has achieved a new status in the field of nutrition and health. This has focussed interest on the dietary fibre content of food materials. The present study was conducted to analyse the dietary fibre content of selected vegetables which are available in Mysore city.

The selected samples were purchased in the city market from five different shops. The edible portions were washed, chopped and dried at 40-50°C. These samples were analysed for moisture, edible portion and neutral detergent fibre (NDF). The selected samples (18) were agathi (*Sesbania grandiflora*), basale (*Basella rubrao*, curry leaves (*Murayya koenigii*), chkramuni (*Bhrami*), doddapatre (*Apium graveolens*), ooty palak (*Tulinum quanifolium*), pndelaga leaves (*Cintella asiata*), honagone (*Alternathera sessilis*), radish leaves (*Raphanus sativus*), shepu (*Peucedanum graveolens*), chocho marrow (*Sechium edule*), drumstick (*Moringa oleifera*), gaint chilles (*Capsicum annum*), plantain stem (*Musa sapientum*), ridge gourd (*Luffa acutangula*), snake gourd (*Trichosanthes anguina*) and tondekai (*Coccinia cordifolia*). The edible portion of vegetables varied between 45 and 100 percent and moisture content ranged between 60 amd94 percent. NDF content of green leafy vegetables and other vegetables ranged between 7 and 42.4 percent and 4.6 and 29.6 percent, respectively. The highest NDF was observed in ondelga (25.1) and snake gourd (29.6 percent). Consumption of 100 g fresh green vegetable and other vegetables provided 0.3 to 3.24 g of dietary fibre.

FCN-61 FUNCTIONALITY OF STARCH IN BOMBAY *HALWA*

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Starch invariably is an important component in traditional foods. *Bombay Halwa* (BH) is made using starch as the base. Starch was isolated from BH prepared using corn, wheat and waxy starches. Specific viscosity, solubility, swelling power, reducing end groups, amylose content, gel permeation chromatographic data (GPC), blue value and absorption maxima of iodine comples (λmax) were compared with corresponding control samples. During the preparation of *Bombay Halwa*, the starch underwent degradation. There was decrease in viscosity and degree of polymerization (DP), increase in solubility and swelling power. GPC studies showed that amylopectin was the fraction that degraded predominantly. However, decrease in amylose content, blue value and λmax indicated that amylose fraction was also affected.

FCN-62 EFFECT OF LONG-TERM FEEDING OF RICE BRAN OIL ON PLASMA AND TISSUE FATTY ACIDS IN RATS

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Experiments were carried out on feeding rice bran oil to rats (experimental) for 20 weeks at 5 and 20 percent levels in the diet as compared to groundnut oil (control) at the same levels. The plasma and liver were examined for total cholesterol. Results showed that in both the cases, the total cholesterol levels were lowered. High density lipoprotein (HDL) formed the major component of cholesterol in both groundnut oil and rice bran oil groups. Twenty percent rice bran oil group showed considerably higher quantity of HDL (53.8 mg/dl), than groundnut oil group (41.7 mg/dl). The fatty acid analysis of plasma and liver showed the same pattern as the type of fat consumed by the animals. Thus, oleic acid formed the major component, 43 and 41.6 percent, respectively, in both groundnut oil and rice bran oil diets, followed by linoleic and palmitic acids.

Interestingly, it was observed that in liver fatty acids in 5 percent oil fed groups, palmitic acid was higher than linoleic acid. However, in 20 percent oil fed group, linoleic acid was higher than palmitic acid. A similar trend was observed with adipose tissue.

FCN-63 A COMPARATIVE ANALYSIS ON THE NUTRITIONAL VALUE OF RAGI *CHHANG* AND RAGI

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Chhang is a traditional fermented beverage from ragi which is extensively consumed by the people in the sub-Himalayan region and other Tibetian settlements. In order to understand the nutritional benefits of this beverage as compared to raw ragi, gross chemical compositions of these were analysed using appropriate methods. The total carbohydrate content of the fermented grain decreased to 65.3 percent from 78.0 percent in original ragi grain; the protein increased from 7.6 to 12.1 percent (on dry weight basis). There was only about 1.0 percent fat in the raw grain. B-complex vitamins like riboflavin increased two-fold, niacin four-fold and pantothenic acid by three-fold. Cyanocobalamin (172.9 μg percent) was synthesised in the fermented grain. Fermented ragi had a pH of 3.8 to 4.1 and contained 3.8 percent (w/w) ethanol and 1.1 percent w/w total acidity. The same showed an yeast count of 1.1×10^9 cfu/g and a lactic count of 4.0×10^9 cfu/g after 6 days of fermentation with *phab* at 25°C. Thus, the nutritional quality of a coarse grain like ragi could be upgraded to a significant extent by fermentation. One litre of the beverage (*chhang*) prepared by extracting 500 g of fermented grain with water was found to contain 30 g solids (apart from volatiles) and 411 to 580 Kcal of energy. However, the spent grain contained more nutrients and calls for effective utilization.

FCN-64 EFFECT OF NON-VEGETARIAN DIET ON SERUM CHOLESTEROL

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Influence of non-vegetarian diet on the total serum cholesterol (TC) and high density lipoprotein cholesterol (HDL-C) concentration was studied in a group of 235 persons belonging to different income groups. It was observed that, persons consuming meat showed an increase in the TC/HDL-C values in all the three income groups i.e. poor, middle and high. The average TC/HDL-C ratio among vegetarians was 1.91 in poor income group, 2.30 in middle income group and 2.52 in high income group, while among non-vegetarians, the corresponding values were 2.28, 2.34 and 2.71, respectively, indicating that individuals consuming meat are comparatively more prone to atherosclerosis.

FCN-65 EFFECT OF PALM OIL FEEDING ON LIPID AND HISTOPATHOLOGICAL CHANGES IN RATS

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Rats were fed palm oil at 5 and 20 percent levels for a period of 18 weeks. Rats fed on groundnut oil at similar percentage levels served as controls. Plasma cholesterol and triglyceride (TG) levels measured were comparatively higher in 20 percent oil fed groups as compared to 5 percent fed groups. The cholesterol and TG levels as obtained in both groundnut oil and palm oil groups fed at 20 percent levels indicate that the higher content of total saturated fatty acids in palm oil (41 percent vs 19 percent in groundnut oil) does not elevate cholesterol levels significantly. Fatty acid levels in plasma indicate the dietary pattern of fatty acid fed, which was reflected in the linoleic and palmitic acid levels of groundnut oil and palm oil groups, respectively (19 to 22 percent and 25 to 30 percent). Erythrocyte fatty acid levels were unaffected in all the groups. Mild centrilobular fatty infiltration was observed in rats fed palm oil at 20 percent level.

FCN-66 POLYGALACTURONASES FROM *ASPERGILLUS NIGER*: PURIFICATION, CHARACTERIZATION AND STABILITY STUDIES

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A simple and rapid method for the purification of polygalacturonases from *A.niger* was developed starting from the commercially available crude enzyme preparation. The steps involved were desalting the enzyme on Sephadex G-25 column, ion- exchange chromatography on CM-Sephadex, rechromatography on CM- Sephadex and finally molecular sieve chromatographpy on Sephadex G-75. The two polygalacturonases differing in molecular weight (66,000 and 44,000) were electrophoretically homogeneous with similar substrate affinity, specificity, pH and temperature optima and a high specific activity of 800-1000 μ\mg protein. The thermal deactivation kinetics follows first order reaction at 45°C with an estimated half life of 60 min. and 30 min. for the 2 enzymes. Nonionic surfactant like Brij-35 enhance the thermal stability. Modification of carboxylic groups of the enzyme with 1,3, di-methyl amino propyl-3-ethyl carbodiimide hydrochloride (EDC) did not affect the activity, but decreased the thermal stability. Sulphur dioxide, a preservative, did not affect the enzyme activity of either purified enzyme or crude enzyme upto a concentration of 13,000 ppm SO_2.

FCN-67 THERMOSTABILIZATION OF LOW MOLECULAR WEIGHT POLYGALACTURONASE FROM *ASPERGILLUS CARBONARIUS*

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Multiple forms of polygalacturonases are produced by *Aspergillus carbonarius*. Two forms of this enzyme differing in molecular weight and specific acitivity were isolated to homogeneity. Of the two forms, the low molecular weight (45000) endo-polygalacturonase had highest reported specific activity of 6000 units\mg protein. The thermal deactivation of this enzyme follows first order kinetics with a half-life of 12 min. at the mid-point of transition i.e 46°C. The enzyme gets irreversibly inactivated at 60°C. Ethylene glycol destabilizes the enzyme as reflected in half-life measurements. D-glycerol, erythritol, xylitol, sorbitol and sucrose enhanced the thermal stability with increase in hydroxyl content in a concentration dependent manner. Sucrose did not affect the K_m and V_{max} of the enzyme reaction. Possibly the enhanced stability in sucrose could be due to conformational change of the enzyme. Citrus-pectin which was a poor substrate for the enzyme, did not enhance the thermal stability of the enzyme significantly.

FCN-68 INFLUENCE OF LYOPHILIYSED LACTIC MICROBES ON MURINE PLATELET AGGREGATION

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Cultured and culture containing dairy products have wide popularity and undeniably possess "health" image. Lactic microbes (LM) are known to possess therapeutic properties besides their ability to produce B-complex vitamins in the intestinal tract. They possess anti-carcinogenic properties and are bactericidal against pathogenic bacteria. Lyophilysed LMs are a substitute for B-complex vitamins. The effect of mixed and individual LM for their influence on platelet aggregation and cholesterol in mice was studied. The platelet aggregation under the influence of lactic microbes was affected, wherein, the percent aggregation maxima for mixed LM recorded was 59.9±3.1 percent uM ADP and 60.2 ±2.03 percent/10 µM collagen for mice treated with lyophilysed LM intraperitoneally, while for orally treated group it was 58.9 ±2.15 and 60.0±2.93, respectivley. The elevated percent platelet aggregation maxima was found to go in parallel with the depletion in serum cholesterol level under the influence of lyophilysed LM. Mixed LM administration showed 50 percent decrease in serum cholesterol level in 30 days time. It can be said that the clinical application of fermented milks containing LM will endorse the high degree of efficiency in keeping good health and maintaining homeostasis by platelets.

FCN-69 NUTRITIONAL ASPECT OF MICROBIAL LIPIDS

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Microbial lipids extracted from *Candida curvata* were fed to forty swiss albino mice of equal age and body weight for a period of 5 weeks. The microbial lipids were fed at 15, 30, 45 and 60 percent levels in addition to corn oil. The digestibility coefficient of microbial lipids compared favourably with that of corn oil, showing 95, 95, 96, 94 and 95 percent in groups, I, II, III, IV and V, respectively. Histological studies of kidney, stomach and intestine were made. No microscopic pathological lesions were observed on liver, kidney, stomach and intestine of the mice at any level of microbial lipids feeding. Histopathological examination showed no degenerative change in any of the test mice. The results suggest that the microbial lipids may be supplemented safely in animal rations for normal nutritional uses upto the extent of about 60 percent. However, further investigations are necessary to identify and explore their utility for human purposes.

FCN-71 EFFECT OF RETINOL MALNUTRITION AND TURMERIC ON MEMBRANE BOUND ALKALINE PHOSPHATASE ACTIVITY

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Retinol deficiency is known to induce changes in the general structure of the cell membrane causing cell damage and alterations in the activity of membrane bound enzymes. Turmeric is a widely consumed food additive in India. Turmeric, in particular curcumin (the active principle of turmeric) shares its antioxidant and antiinflammatory properties with retinol. The present investigation deals with the influence of retinol deficiency and curcumin or turmeric feeding on membrane bound alkaline phosphatase activity in rat liver and kidney. Rats were made retinol deficient by pair-feeding a synthetic diet devoid of retinol for 6-8 weeks. At the end of the stipulated time, half of the animals in this group were sacrificed and another half were put on a diet containing 0.1 percent curcumin or turmeric separately for additional 3 weeks. The alkaline phosphatase enzyme activity was decreased in the experimentally induced retinol deficient rat liver and kidney by 49 and 66 percent, respectively compared to the controls. The K_m increased in retinol deficient kidney by 40.5 percent and V_{max} by 14.2 percent, while in the liver the K_m was increased by 189 percent, while V_{max} showed an increase of 51.5 percent as compared to the controls. The cholesterol: phospholipid ratio registered a decrease by 73 to 79 percent in the retinol deficient rat liver and kidney. Curcumin or turmeric feeding to retinol deficient rats reverted the values close to the control values. Turmeric was more able to revert these changes.

FCN-71 REGRESSION OF CHOLESTEROL GALLSTONES (CGS) BY FEEDING SPICE PRINCIPLES IN MICE

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It has been earlier reported that dietary curcumin and capsaicin reduced the incidence of experimentally induced cholesterol gallstones (CGS) in mice and hamsters. In an attempt to find out whether spice principles (Curcumin or Capsaicin) feeding regress the already formed CGS, male young mice were fed a lithogenic diet for 10 weeks to induce CGS. These animals were transferred to diets containing spice principles for 5 or 10 weeks. Feeding 0.5 percent curcumin or capsaicin (5 mg per 100g diet) for 5 weeks regressed the CGS in 45 and 64 percent of the animals, respectively. Feeding of the two spice principles for 10 weeks caused rgression of CGS in upto 80 percent of the animals. The lithogenic indices were lowered to less than 1 in curcumin or capsaicin fed mice. There was a significant increase in the biliary bile acids in the spice principles fed animals. It was thus demonstrated that curcumin or capsaicin feeding caused regression of experimentally induced CGS in mice.

FCN-72 EFFECT OF COOKING IN IRON UTENSIL ON THE TOTAL AND BIOABSORBABLE IRON CONTENT OF SOME VEGETABLES

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Vegetables like spinach, amaranth, kulfa and bottlegourd were cooked in iron and non-iron pans, respectively. Cooked and uncooked fresh vegetables were used for analysis of total iron and bioabsorbable iron (*in vitro*). Total iron content in vegetables fresh uncooked and cooked in non-iron utensil was highest in amaranth followed by kulfa, spinach and bottlegourd, while bioabsorbable iron was highest in amaranth followed by spinach, bottlegourd and kulfa. Total and bioabsorbable iron increased on cooking in iron utensil and percentage increase was 63 (amaranth) to 374 (spinach) percent in total iron and 171 (bottlegourd) to 631 (kulfa) percent in bioabsorbable iron as compared to that of cooked in non-iron utensil. The percent bioabsorbption of total iron was found to be highest in vegetables cooked in iron utensils.

FCN-73 NUTRITIVE VALUE OF WHEAT-GREENGRAM-CARROT TEMPE

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Tempe is a popular Indonesian food made by fermenting soybeans with *Rhizopus oligosporus* and *Rhizopus oryzae*. Tempe-like products also could be made from other than soya such as blends of various cereals and pulses. In the present study, the nutritive value of wheat-greengram-carrot (40:40:20) tempe manufactured with above cultures was determined. Soybean dry tempe had thiamine, riboflavin and vitamin-A, respectively as 1.22 mg, 1.64 mg and 50.0 µg per 100 g. Whereas tempe prepared with changed raw ingredients as in present study had 4.43 mg, 0.50 mg and 513.65 µg, respectively per 100 g. Blended tempe had higher thiamine and vitamin-A contents. Energy, protein, fat and carbohydrate values on percentage basis were found to be 439 K.Cal, 24.0, 3.5 and 63.1 g, respectively and for crude fibre and ash 2.4 and 1.9 g. Calcium and iron contents were 843 and 4.8 mg percent, respectively. This tempe could be used in feeding programme to eliminate protein calorie malnutrition and vitamin-A deficiency prevalent in children and women. Blended tempe had better acceptability and cheaper cost than the conventional soya tempe.

FOOD ENGINEERING

FEG-1 DEVELOPMENT OF GORGAN NUT PROCESSING MACHINE

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Gorgan nut (*Euryale ferox*) is a seed of an aquatic herb and is characterised by its hard seed coat (shell), black colour, and spherical shape with diameter ranging from 4.5 to 14.5 mm. Edible part of the nut is its starchy kernel which is closely attached to the shell and requires high temperature thermal treatment and mechanical action (impact) to separate out from the nut. The current method of gorgan nut processing in India is manual and causes burn injuries to the processor's hands. Attempts have been made to determine the suitable processing condition of the nut and develop a machine. The machine consisting of a roaster and an impacter unit was designed, fabricated and tested. The performance of the machine was evaluated taking into account of percent popped kernel (*makhana*) and production of grade I *makhana*. The machine gave satisfactory performance and it was possible to obtain 95.6 percent of popping and 84.5 percent of grade I *makhana* at optimum operating conditions. The machine is economically viable and recommended for commercial production and use by the gorgan nut processors.

FEG-2 DESIGN, FABRICATION AND TESTING OF POMEGRANATE SEED EXTRACTOR

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A power operated pomegranate seed extractor has been designed to separate the seed from the pomegranate variety "Ganesh". The machine consists of hopper, shaft with knives, concave, outlet chutes for seed and rind and power transmission. The machine was tested for its efficiency to separate the seed from whole pomegranate fruit. The fruit can be fed continuously into the machine, seed and rind come out from separate outlets. The performance was compared with the hand-separated seeds. The seed separation efficiency of the machine was 86 percent and the average purity of the seed was 96 percent. The rind separation from the seed was very efficient. The results indicate that, the juice percentage in the fruit was 50.71 on fruit weight basis. The average edible portion (seed) was 71.65 percent on fruit weight basis. The capacity of the machine was estimated to be two quintals per hour. The machine can be operated by one HP motor and needs one labour. The overall design and performance of the machine will be discussed.

FEG-3 DESIGN AND FABRICATION OF LOW-COST ENERGY EFFICIENT MULTIPURPOSE SAND ROASTER

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Sand roaster is used for roasting and puffing operations of different foodgrains. The designed and fabricated multipurpose sand roaster is less costly and energy efficient. The multipurpose sand roaster uses wide range of fuel for sand heating and operated manually. The multipurpose sand roaster can be efficiently operated with 15:1 sand to grain ratio by weight at 230°C sand temperature and 15-20 sec. puffing time combination per batch. It has a cylindrical wall, roasted or puffed and discharged through the same opening manually. When operated with electricity, the temperature was controlled automatically by a bimetallic temperature controller, whereas for other fuel, this electric heating assembly can be detached easily.

FEG-4 DIESEL GENSET EXHAUST OPERATED ABSORPTION COOLING SYSTEM

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Because of frequent power cuts, and unreliable grid electric supply, diesel genset (of above 100-200 KW capacity) has become an integral part of coffee curing works and cashew processing factories. Exhaust gas from these genset comes out at about 300- 400°C. Vapour absorption system utilising the heat content of this exhaust gas as power source was studied to evaluate cooling potential of such system from exhaust gas characteristics of typical genset. Preliminary calculations indicate that the system can meet part or even full cooling load of the factory. Due to many novel features of this system, such as negligible fuel cost, quiet and practically maintenance-free operation, this system had great potential of its applications in many cashew processing factories or coffee curing works having diesel gensets for captive power generation.

FEG-5 ENERGY ACCOUNTING AND CONSERVATION IN OIL EXTRACTION PLANT

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Oil is extracted from oilseeds by rupturing the oil cells or by solvent percolation. Electrical and thermal energy consumed is a major contributor to the operating cost of an oil extraction plant. The data on energy requirement were collected for crushing 400 tonnes of mustard seeds per day using

mechanical expeller and solvent extraction unit. The expeller required 206.08 kwh of electrical energy and 6.25×10^5 kcal of thermal energy per tonne of oil extracted. The corresponding figures in case of solvent extraction unit were 277.2 kwh and 9.44×10^5 kcal, respectively.

FEG-6 MODELLING OF AN ANIMAL-FEED EXTRUDER

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Analysis has been carried for the design and development of an animal-feed extruder. The animal feed in the form of pellets was prepared. The knowledge of feed material and extruder characteristics was used to predict the temperature and pressure profiles when the extrudate was inside the barrel. In spite of high temperature, boiling/flashing off of moisture does not take place, because of high pressure produced inside due to the presence of die at the end. The phase changes taking place in extrudate and their effect on its composition as well as the mechanism of fluid flow and energy transfer were established on a laboratory model. Single screw extruder was designed with L/D ratio as 10:1 while other optimized dimensions such as flight- height at feeding and metering section, Die-openings, pitch, and helix-angle were based on theoretical understanding and intuitive assumptions. A computer programme in the PASCAL language was written to carry out the calculation and predict the extruder performance. This animal-feed extruder was satisfactorily simulated. The results were compared with those experimentally measured at the same operating conditions.

FEG-7 DESIGN OF A STERILIZER FOR THERMAL PROCESSING OF INDIAN FOODS IN FLEXIBLE POUCHES AND ALUMINIUM CANS

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The objective is to design and fabricate a semi-automatic horizontal sterilizer to suit Indian food industries for batch processing of ready-to-eat foods. The sterilizer, of size 1050 mm x 1200 mm x 2100 mm with capacity of 250 kg per batch was made of stainless steel of grade AISI 316. It was designed to operate at 1.75 kg/cm^2 steam pressure corresponding to temperature of 125°C and was suitable for processing of foods in flexible pouches as well as thin-walled aluminium cans. The food materials could be loaded/unloaded easily using carriage and trolleys. The unit was incorporated with rapid heating/cooling cycles with provision for superimposition of compressed air during heating and cooling for pressure compensation. The operator will have complete control over process cycles from the control panel with minimum physical movements.

FEG-8 FOODLIFE: A SOFTWARE PACKAGE FOR PREDICTION OF SHELF-LIFE OF MOISTURE-SENSITIVE AND SELECTION OF FLEXIBLE PACKAGE STRUCTURES

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A software package for predicting shelf-life of moisture- sensitive foods and selecting suitable flexible package structures has been developed. Named as FOODLIFE, the software facilitates computer simulation of changes in water activity and moisture of a food product with respect to time under specified packaging and storage conditions. It also enables computation of moisture of a food product with respect to time under specified packaging and storage conditions. It also enables computation of moisture barrier requirement of the package for desired shelf- life. The programme is based on numerical solution of the steady-state moisture transport equation incorporating Guggenheim-Anderson-de Boer equation for moisture sorption of the food product. Data on moisture sorption characteristics of various food products and water vapour permeabilities of packaging films can be taken from a built-in database or input by the user. Facilities to update or expand the database are also provided. The software features user-friendly menu-driven interface and is useful in reducing or even totally eliminating expensive and time-consuming shelf-life experiments for moisture- sensitive foods.

FEG-9 DEVELOPMENT OF COMPUTER PROGRAM FOR THE MAINTENANCE OF MACHINERY/EQUIPMENTS IN FOOD PROCESSING INDUSTRY

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In this study, an attempt was made to develop a computer program using dBASE III plus language. The development of software for the control, planning and scheduling of preventive maintenance of machinery in food processing industry are discussed. The user- friendly software consists of EQUIPMENT MASTER, CHECKLIST, MAINTENANCE CHART, LUBRICATION SCHEDULING and various Reports. Checklist is the main information needed to the lower level management people to carry out the maintenance task effectively. Using maintenance chart, a skilled mechanic will be able, possibly assisted by a electrician, to rectify all defects that might occur. The data were collected regarding the lubrication points, the type of oil used and the same was computerized to get lubrication schedule report. The other specific reports that can be generated are Maintenance Inspection Report, Breakdown Report, Inventroy control master file, Inventory control activity file, Vendor file, Parts to be ordered file, Corrective maintenance recommendation report and Maintenance work order.

FEG-10 DEVELOPMENT OF SMALL SCALE GARLIC BULB BREAKER AND CLOVE PEELER

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Garlic is one of the important condiments used in food and pharmaceutical preparations. The conventional method of garlic bulb-breaking and clove-peeling is very cumbersome, time consuming, unhygienic and expensive. Therefore, two small scale machines viz. garlic-bulb breaker and clove-peeler were developed to disintegrate bulbs into cloves and to remove outer skin of cloves, respectively. The bulb-breaker (40-50 kg/h) consists of a hollow cylinder with wooden battens, a grated concave and a handle to operate it. The machine costs Rs. 400/- with an operating cost of Rs 0.10 per kg. The clove-peeler (4-5 kg/h) consists of two inclined cylinders lined with suitable abrasive material and a handle. The machine costs Rs. 450/- with the cost of peeling at Rs. 0.90 per kg.

FEG-11 MASS TRANSFER IN THE EXTRACTION OF RICE BRAN OIL USING SUPER CRITICAL CARBON DIOXIDE

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Super critical fluid extraction is gaining importance in many fields of food technology. Mass transfer phenomenon in the extraction of ricebran oil using super critical carbon dioxide was studied as a function of pressure (160-240 bar), bed height (55-165 mm) and flow rate (0.1-0.23 mm/s). Mass transfer model in the fixed-bed extractor was solved using modified Euler method. As the bed height increased, overall mass transfer coefficient (k) decreased. The value of K increased with an increase in pressure. Increasing the flow rate of carbon dioxide did not affect the k values in the range of studies conducted.

FEG-12 EVALUATION OF HEAT TRANSFER PHENOMENON DURING COOLING OF RICE BRAN OIL

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Data on cooling of rice bran oil (RBO) useful for dewaxing it, are presented and plotted to determine the heat transfer coefficients. Systems like double pipe exchanger and stirred jacketted vessel were employed. The former was studied at low Reynolds number (Re) for inner pipe carrying

RBO and latter equipped with either paddle,anchor or propeller at Re which were functions of their design. The properties of the fluids were determined at their caloric temperatures. The laminar flow for non-Newtonian fluid was evaluated by inclusion of the required correction factor. Almost doubling the annulus Re (Rea) for the chilled water from 1533 to 3143 or acquiring an outlet temperature difference between the fluid of 16.5°C, the value of annulus heat transfer factor (ja) did not change significantly, but by 6 percent in case of latter (viz., temperature change). However, value of jacket heat transfer factor comparatively improved by nearly 7.5 times concluding it as more efficient system.

FEG-13 RESISTANCE OF SOYBEAN TO AIR FLOW IN STATIC BED AND BEDS AT INCIPIENT AND DEVELOPED STATES OF FLUIDIZATION

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In order to use a fluidized bed as a thermal reactor for certain heat and mass transfer exchange process, it is imperative to know the resistance offered by a bed of particulate solids to the flow of air through it in different stages encompassing static, incipient and fully developed state of fluidization. This study formed a part of an overall investigation pertaining to hydro- thermal treatment of soybean in fluidized bed to process edible stable full-fat soy flour. Fluid bed heated soybean solids greatly increase heat and mass transfer rates and thus affect substantial process time and cost savings; this also means less damage to food nutrients present *in situ*.

The resistance offered to the flow of air through static soybean beds was found proportional to the thickness of the bed. The data on pressure drop and superficial air velocity across the static bed did not fit the theoretical Ergun equation. Inclusion of a suitable porosity term damped out such deviation from the theoretical model. In expanded beds at incipient fluidization, the resistance was maximum at the centre and minimum at the walls. This pattern changed completely at higher rates of air flow corresponding to fully developed state of fluidization. Pressure drop increased linearly with bed depth, both for expanded and fluidized beds.

FEG-14 ENERGY AUDIT IN MILK DRYERS

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With the increase in milk production, a large number of dryers have been installed at various dairy plants in the country. The dryers consume more energy as compared with evaporators. It is necessary to be energy conscious for this highly energy intensive unit operation. The information on energy requirement for converting milk into milk powder provides quantitative data which are

useful in selection of energy generating system and also quantify different heat losses during processing. The present study has been carried out to collect data on steam consumption, electrical energy requirement, quantity of concentrated milk and milk powder. Similar data have been collected for spray dryer. The heat and mass balance was carried out to determine various losses. The energy utilized in processing, in roller dryer was estimated to be 50.12 percent, thermal losses with condensate, with product and due to convection and radiation were found to be 10.70, 0.33 and 38.85 percent, respectively. The average energy consumption was 10,040 KJ/kg of dry powder. The energy utilized in processing, in spray dryer was estimated to be 21.05 percent. The energy losses with exhaust air with the product and due to convection and radiations were found to be 58.52, 0.19 and 20.24 percent, respectively. The average energy consumption has been estimated to be 4820 KJ/Kg. of dry powder.

FEG-15 ENERGY ANALYSIS IN *PANEER* PROCESSING

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The dairy industry consumes considerable amount of energy in processing milk and milk products. Due to the present energy crisis and continuous rise in the prices of fuel, it has become essential to critically evaluate energy requirement for various unit operations in dairy processing The present study on energy analysis in *paneer* processing provided data for energy consumed during *paneer* making and heat losses with condensate from product surface due to convection and radiation. The information was generated on pressure of steam, steam consumption, quantity temperature of condensate, whey and *paneer*, respectively, for different batch sizes of milk processed. The average amount of steam consumed in processing milk to *paneer* was found to be 0.13 kg/kg of milk. The average amount of heat utilized in processing was estimated to be 187.5 KJ/Kg. of milk. The average percentage heat utilized in processing was estimated to be 56.48 percent. The average thermal losses with condensate, due to convection and radiation and from product surface were estimated to be 13.10 and 30.42 percent, respectively.

FEG-16 FLOW MODELLING OF A CONTINUOUS *CHAPATI* (UNLEAVENED FLAT BREAD) FORMER

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Volumetric flow rate was studied in the die of a indigenously designed continuous *chapati* (unleavened flat bread) forming unit. Variables included were screw speed, ratio of length to die width, barrel diameter to die width, product moisture and temperature. A mathematical model was developed to predict the flow rate and torque requirements. Error analysis was used to calculate

the effective flow rate and torque. Flow rate was affected by product moisture and die width. For a constant pressure drop, flow rate increased, as die width and product moisture increased. The flow rate and torque equations used in this study were,

$$Q = G_1 G_2 N F_{dt} (1-d/H) + G_3 G_4 F_{pt}/\mu (P_1-P_2/L) (1+f) \text{ and}$$

$$T = G_5 (G_6 \mu N + G_7 \mu dN + G_8 \mu Q)$$

respectively where,

Q is the volumetric flow rate, **T** the torque input, F_{dt} the total drag flow, F_{pt} the total pressure flow, **N** the screw speed, **d** the flight clearence, μ the viscosity of the dough in the channel, T_f correction of pressure flow through flight cleareance, **H** the channel depth, **L** Length of the screw, P_1 and P_2 dough pressure at input end and output end and G_1 to G_8 are geometric constants.

FEG-17 LACTOSE MANUFACTURE USING MEMBRANE TECHNOLOGY

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Whey utilization for lactose manufacture not only accrues economic benefits, but also alleviates the BOD in effluents. Lactose finds application in baby foods, bakery, confectionery and in pharmaceutical industry. A cost-effective technology for the production of lactose was standardised using a two step Ultrafiltration (UF) and Reverse Osmosis (RO) process for deproteinization and concentration. Neutralization of whey was found to increase the flux rate during UF and RO. Deproteinization of whey by UF alone was insufficient and necessitated further removal of proteins by heating at 95°C with addition of 0.5 percent (w/v) of 20 percent calcium chloride solution. Preconcentration of UF permeate by RO at 50°C and 35 bar pressure upto 15 percent total solids was followed by concentration by a Scraped Surface Heat Exchanger upto 70 percent total solids. Crystallisation followed by washing with demineralised water and tray-drying gave 99 percent pure lactose with a yield of nearly 75 percent.

FEG-18 MODELLING OF MOISTURE TRANSFER IN UNIT PACKAGES OF A FOOD PRODUCT AS AFFECTED BY BULKING IN A SECONDARY PACKAGE

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Mathematical models were developed for computer simulation of moisture transfer in unit packages of a food product which were in turn bulked in a secondary package in a rectangular

parellelopiped configuration. A generalised steady state equation for moisture transport through a unit package as affected by bulking was first derived taking into consideration the areas of contact with surrounding unit packages and permeabilities in different directions. The Guggenheim-Anderson- de Boer equation for moisture sorption isotherm was differentiated with respect to time and combined with the above equation to result in a system of simultaneous first order differential equations relating the changes in water activities in various unit packages to storage time which were solved by Runge-Kutta-Gill numerical method. The corresponding moisture changes were obtained by interpolation in the original sorption isotherm equation. The models and the computer program developed can be used for designing unit and secondary package combinations to achieve desired shelf-life.

FEG-19 EFFECT OF VANE PROFILE ON THE PERFORMANCE OF CENTRIFUGAL SHELLER

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Centrifugal sheller works on the principle of impact for shelling grains. Paddy was fed to the centre of an impeller having guide vanes. High speed of rotation of the impeller throws the grain outwards onto a stationary rubber ring due to centrifugal force, effecting dehusking. Requiring little skill in its operation, it can even handle high moisture paddy and mixture of varieties. Speeds as high as 30 to 40 meters per sec are normally required (which was high by rice milling parlance) for 80 to 90 percent shelling. To improve the shelling efficiency at relatively lower speeds, different vane profiles (Radial, Curved and Straight- Curved) were incorporated. For the same shelling efficiency, 5 to 8 percent reduction in speed was achieved with the improved impellers. The paper presents comparative performance of the impellers, for raw and parboiled paddy.

FEB-20 TECHNICAL TRANSFER OF TRAY DRIERS

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There has been a need by the farming community to dry different herbs for herbal teas and cooking uses. In the market, there existed large SS driers costing £ 25,000. Attempts to develop an alternative, resulted in evolving a low cost tray drier costing about £ 2,000. This consisted of an angle iron frame, a plywood cabinet and iron work for the lifting gear. A space heater was used as the heat source. This is a semi-continuous drying system. The trays nearest to the heat source were removed as soon as the material was dried. All the other trays moved gradually into the hot

zone. The drying efficiency was good wherein 360 kg of fresh herbs were dried in 24 h shift. The drier could be locally got fabricated and repaired.

FEG-21 ADOPTION OF TINY TECHNICAL OIL EXPELLER SYSTEM IN ZIMBABWE

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Zimbabwe is faced with the problem of supply and demand of vegetable cooking oil. In this regard, Tiny Technical Oil Expeller System was transferred as a very successful appropriate technology transfer to Zimbabwe. The system is produced by an Indian company and is essentially a small scale version of a complete oil processing system. This requires a work force of 5 people and can process sunflower or groundnut seeds at the rate of 250 tonnes per year. A collaborative project was started in Zimbabwe and investigations have been completed. The system is viable and a programme of promotion is now under way in Zimbabwe.

FEG-22 A LOW-COST INDIGENOUS MANUALLY-OPERATED VACUUM PACKAGING MACHINE

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A simple low-cost indigenous manually operated vacuum packaging machine was designed and fabricated. In the actual design, the filled pouch was mounted between the bar heat sealing jaws in an air tight chamber (an adaptation of house-hold pressure cooker) and the air was evacuated by a leg operated cycle pump or a small vacuum pump (optional) through a specially designed valve. Heat sealing was done immediately after evacuation by means of an externally operated lever covered with a bellow between the lever and the lid. The chamber lid consisted of a thermosat for controlling temperature for heat sealing, a vacuum gauge for the indication of vacuum, and an air vent for the release of vacuum after heat-sealing. Provision was also made for gas flushing through a valve. The machine was suitable for 2 pouches of 200 ml capacity and 1 pouch of 400 ml capacity per operation. At present, chamber types of vacuum packaging machines are available in India, which cost around Rs 1.0 lakh. The approximate cost of this new design is around Rs.4,000/-. The machine is highly inexpensive when compared to the conventional chamber types of vacuum packaging machines.

FEG-23 DEVELOPMENT OF FOOD EXTRUDER FOR BAJRA

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High nutritive value at low cost of bajra can help in improving rural economy and health. The deep grey pigment of bajra imparts unacceptable blackish colour, deficiency of gluten creates problems in getting proper binding of bajra and makes it difficult to obtain soft cook. A simple process was developed and optimized for making extruded products from bajra with combinations of moth and wheat to overcome the problems of colour, binding and cooking of dough. The product made in combination of bajra, moth and wheat (2:2:1) was found most acceptable by a consumer test panel. A hand operated single screw food extruder (450 mm length, 50 mm diameter, 30 mm pitch, 4 mm flight width and root diameter varying from 25-40 mm) with a provision of electrical heating was developed and tested. Its performance has demonstrated that continuous process for extruded products from bajra was possible. The best product was obtained at 5 rpm using 1000 watts heating element.

FEG-24 DESIGN AND ECONOMIC ANALYSIS OF CONTINUOUS COUNTERCURRENT SC-CO_2 PROCESSING OF ANHYDROUS MILK FAT

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A continuous counte current supercritical carbon dioxide (SC-CO_2) system for fractionation of anhydrous milk fat (AMF) was designed, built and used to obtain fractions of different physico-chemical and functional properties. Based on mass transfer studies of this proces, economic analysis of manufacturing plants was performed. Equipment was sized for six commercial scale plant capacities for processing upto 3200 tons/yr. Capital investment, annual manufacturing expenses, revenues, sales and payback time were calculated for a plant operating in the U.S. Sensitivity to other geographic locations like India, was studied by varying labour cost, raw material cost and corporate tax accordingly. An equipment scale-up index of 0.61 was obtained. For processing 3200 tons/year by a plant located in the U.S., conversion cost was 16 c/kg. Such a plant requires a capital investment of $ 4 million and manufacturing expenses of $ 7.5 million/yr. Selling prices assumed for 15 percent ROI (payback is 6.7 years) add further 25 c/kg to the base price.

FEG-25 A COMPUTER AIDED DESIGN OF MICROWAVE OVEN FOR UNIFORM COOKING

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In recent times, food preparation through microwave oven is gaining momentum owing to its simplified approach and non- hazardous environmental viability. Many researchers and engineers are actively engaged to meet the present day growing demand for the microwave oven with low-cost and high efficiency. One of the major drawbacks encountered is the non-uniformity of the food materials. An attempt was made to develop some non-existing expressions to relate the microwave field strength to the angular position and to the time of exposure of the food materials The expressions so developed which were first of its kind can be used as a ready-made tool to explore a long way in overcoming the phenomenon of better uniform cooking of the food materials in a microwave oven. The design expressions so developed could lead to design of highly microwave oven for non-uniform food materials maintaining the calorific and nutritional values

FEG-26 SUITABILITY OF LACQUERED ALUMINIUM CANS FOR FOOD PRODUCTS

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Defence Food Research Laboratory has developed aluminium cans made out of AA 3004 alloy in lieu of tin cans. The can interior was coated with food grade epoxyphenolic lacquer for its high corrosion resistance and extensive use in tin cans. While processing of the food products to ensure commercial sterility, severe thermal treatment is applied and this may lead to either peeling of lacquer or impart of lacquer taste and flavour to the food products. In this study, the compatability and the behaviour of the lacquer during thermal processing in the presence of food simulated acid, semi-acid and non-acid systems was studied. Determination of pH and total solids ensured the absence of leachable substances. Visual examination revealed the absence of peeling, bloom and other physical damages. Canning of bland sweet semolina pudding showed that the lacquer did not impart any taste or flavour to the food. Therefore epoxyphenolic coated aluminium cans were found suitable for thermally processed foods.

FEG-27 **FLUIDIZED BED DRYING OF MANGO POWDER**

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The fluidized bed drying of mango powder was studied using a laboratory model fludized bed dryer. Mango powder of 5.5 percent (db) moisture content and average diameter of 136.5 μ was dried using 55°C air of 35 percent relative humidity. Three loadings of 21.6, 36.0 and 50.6 kg/m^2 were used. The bed temperature and moisture content of the powder at different time intervals were obtained. From energy balance, a model was developed which could predict moisture content as a function of bed temperature, air temperature drop and latent heat. Relationship was obtained between pressure drop, velocity of air and bed height. Drying rate was modelled assuming a straight line falling rate. All models were validated using 50.6 kg/m^2 loading. The diffusion coefficient was found as 2.9×10^{-5} m^2/s, the heat transfer coefficient was 0.15 m/s. The predicted moisture content values agreed with the experimental ones within 12.5 percent. The final moisture content of the powder was 3.5 percent and the maximum bed temperature was 41°C.

FRUIT, VEGETABLE AND PLANTATION PRODUCTS

FVP-1 EFFECT OF MICROWAVE TREATMENT ON THE DEHYDRATION OF SPINACH

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A study was carried out to improve dehydration characteristics and the quality of dried spinach. The fresh leaves were cut into strips of one fifty inch and were exposed to microwaves for 8, 14, 20, 30, 40, 50 and 60 sec and dried at 70°C and 80°C in air dryer. The results showed enhanced drying rate for microwave exposed spinach. As time of exposure to microwave was increased, the drying rate increased. Spinach exposed to 60 sec dried in 3 h at 70°C and in 2 h at 80°C as against 7 and 6 h for control, respectively. Quality of microwave treated dried spinach improved significantly with better rehydration characteristics and attractive light green colour.

FVP-2 COMPARATIVE STUDIES ON CONTROLLED LOW TEMPERATURE VACUUM DEHYDRATION AND OTHER METHODS OF DEHYDRATION OF BREADFRUIT

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In a comparative study on controlled low temperature vacuum (CLTV) drying of breadfruit dice, for the preparation of "quick- cooking" or "ready-to-cook" dehydrated curried vegetable formulations, the product temperature was maintained between -5 and +40°C, by pre-heating in a through-flow drier at 50°C for 1 h, followed by drying in a freeze-drier (plate temp 48 to 52°C, condenser temp. -43 to -68°C) was compared with other conventional methods viz., vacuum-shelf-drying (VD), cross-flow drying (CFD) and freeze-drying (FD) (product temp. in FD ranged between -35 and 40°C). CLTV gave a product with the rate and extent of dehydration, shrinkage, rehydration and sensory quality equivalent to conventionally freeze-dried product and was superior to VD and CFD products. Possible savings in cost by CLTV in comparison with FD are discussed.

FVP-3 EFFECT OF MICROWAVE TREATMENT ON DEHYDRATION OF GARLIC

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The commercial sample of garlic bulbs used in this study contained 88.5 percent cloves with 4.7 percent by weight of papery skins and basal tips. The deskinned garlic cloves containing 61.3 percent moisture and 0.265 percent allicin/volatile oil were subjected to microwave treatment for 8-

40 sec. in one-, two-, or three-stages; the optimal treatment time was found to be 20 sec. in one-stage or 14+8 sec. in two- stage treatment which effected 19 percent loss in its weight without any appreciable change in colour with concurrent advantages of reduction in requirements of both drying temperature and time. The microwave-treated and dehydrated garlic was apparently devoid of estimable content of volatile oil presumably, because of decomposition and /or transformation of allioin. However, it was found to possess high inhibitory activity against sewage microflora. This pre-treatment, shall have utility in producing dehydrated garlic products devoid of allicious odour disagreeable to affluent section of the society which has an appreciation for garlic for its anti-bacterial and/or medicinal properties.

FVP-4 EFFECT OF DIFFERENT POST-HARVEST TREATMENTS ON SHELF-LIFE OF BANANA

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In the present investigation, mature banana hands "Cv. Basrai", were given Ethrel (500 ppm) followed by Bavistin (500 ppm) treatments. The hands were stored at room temperature and in zero energy cool chamber. It was found that, Ethrel and Bavistin treatments coupled with the storage environment played a significant role in extending the shelf-life of banana. The Ethrel and Bavistin treated fruits in cool chamber had maximum shelf-life of 26.5 days as compared to 14 days at room temperature. The cool chamber stored fruits looked fresh and firm. The quality of these fruits was found to be organoleptically acceptable.

FVP-5 UTILIZATION OF CITRUS (BHADRARI LEMON) WASTE

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Studies were conducted to utilize citrus waste material like peel and seed of the Bhadari lemon fruit. The fruit yielded about 20 percent juice and 0.3 percent peel oil. The waste portion include albedo (34 percent), flavedo (20 percent), seed (2 percent) and rag (24 percent). The flavedo portion was utilized for extraction of essential oil and the albedo portion for making peel candy. The seeds contained 31.8 percent fatty oil. The fatty acid composition of seed oil showed Palmitic acid (25.65 percent), Palmitoleic acid (0.72 percent), Stearic acid (2.21 percent), Oleic acid (26.92 percent), Linoleic acid (39.59 percent) and Linolenic acid (4.91 percent). Linoleic acid, an essential fatty acid was present in good amount and was quite comparable with groundnut oil. Hence, the seed oil could find use as an edible oil after debittering and refining.

FVP-6 EFFECT OF VARIOUS POST-HARVEST TREATMENTS ON SHELF-LIFE OF BER

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The present investigation was undertaken to study the effect of various post-harvest treatment on shelf-life of ber "Cv. Umran". It was found that, the fully mature golden yellow coloured, wax (WXO 6 percent) treated, polyethylene (150 gauge and 2 percent ventilation) + CFB packed ber fruits could be successfully stored upto 29 days in cool store (4 to 6°C and 75 to 80 percent RH), followed by 15 days in cool chamber (14.50 to 18.32°C and 91 to 95 percent RH) as compared to 6 days at room temperature (9.13 to 23.58°C) and 28 to 74 percent RH) without any treatment. Storage of ber with simple post-harvest treatments in cool chamber was found to be beneficial for extending its shelf-life as it did not require any energy and easily installable with cheap, locally available raw material.

FVP-7 STANDARDIZATION OF DEHYDRATION TECHNIQUES FOR DIFFERENT VARIETIES OF BER (*ZYZYPHUS MAURITIANA* Lamk)

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Investigations were carried out to evaluate the dehydration techniques for different varieties of ber. The fruits of three varieties viz. Illachi, Mudia Murhara and Umran were taken and subjected to various treatments like sulphuring, blanching, (water and steam) and osmotic dehydration alone and in combination with other treatments. Osmosis in 70°Brix sugar syrup at 50°C was done to partially dehydrate the fruits followed by either sun drying or oven dried. The dehydrated product obtained after water blanching + osmosis yielded excellent product with higher retention of ascorbic acid and maximum recovery. Therefore, osmo-air sun drying was economical and an energy saving process for the dehydration of ber. Varieties, Illaichi and Umran were found most suitable for drying purpose. Dipping of fruits in sugar syrup for 24 h. for varieties Mudia Murhara and Umran have been suggested.

FVP-8 EVALUATION OF DIFFERENT VARIETIES OF BER AND PROCESSING METHODS FOR PREPARATION OF CANDY

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The present investigation was undertaken to assess the suitability of different varieties of ber grown commercially in Haryana for processing of candy. Ten ber varieties viz. Gola, Kaithli, Mudia murhara, Banarasi karaka, Sanauri No.3, Rohtak safeda, Umran, Kath phal, Ponda and ZG3 were

taken. The processing was done by slow and quick methods. In slow process, the pricked fruits were blanched in boiling water for 5 min. and kept in 40° Brix sugar syrup containing 0.3 percent acid. The concentration was raised by 10° Brix on alternate days and maintained at 70° Brix for 15 days. In quick process, the pricked fruits were boiled in 50° Brix syrup for 6 to 8 min. and kept overnight. The strength was raised to 70° Brix on second day and maintained for a week. Sugar concentration in ber candy was obtained above 70 percent in quick process and was rated excellent. Thus, the time consuming slow process can be substituted by quick process. Varieties, Mudia murhara, Rohtak safeda, Sanauri No.3 and Banarasi karaka were found more suitable for candy processing under quick process.

FVP-9 RETENTION OF ANTHOCYANINS OF POMEGRANATE JUICE PACKED IN GLASS BOTTLES

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In the present investigation, the pomegranate juice (Cv.Ganesh) was packed in colourless and amber colour glass bottles and stored at room temperature (29.5-21.43°C) and low temperature (5°C). It was found that after the storage period of 180 days, there was maximum retention of anthocyanins (30.70 mg percent) in pomegranate juice packed in amber colour glass bottles and stored at low temperature.

FVP-10 EFFECT OF METHOD OF JUICE EXTRACTION ON THE QUALITY OF KINNOW

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The quality of kinnow mandarin products is affected by the methods of its juice extraction. The five different methods of juice extraction were employed viz. hydraulic pressing (HP), hand-reaming (HR), screw type juice extractor (SE), crushing without peel (CWP) and crushing with peel (CP). The juice yield was in the range of 36.36 to 48.40 percent. The pomace possessed variable amounts of pectin, and the peel also provided pectin and essential oil. The CP method had the highest percentage for juice, TSS, ascorbic acid, pectin, cloudiness, viscosity and pulp content of the juice, and pectin of pomace, but lowest in acidity. A strong positive relationship existed between the pulp content and cloudiness of the juices. The sugars were not much influenced by the method of extraction. A tremendous effect was however, noticed on the carotenoids and Hunter colour values of the juices. The juice obtained from CP method was not acceptable at all due to its intense bitterness, while the juices obtained by hydraulic pressing and hand reaming were without any bitterness.

FVP-11 STUDIES ON THE PREPARATION AND STORAGE OF CARROT JUICE BEVERAGES

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Carrots are one of the important vegetable crops in India and is known to be the richest source for Beta carotene, an important nutrient in the human diet. Among the carrot varieties screened, "Bangalore local" and "Ooty hybrid" have been found to be suitable for processing for their deep orange red colour and sweet taste with rich carrot flavour. Optimum conditions were worked out for extraction of good quality carrot juice which on subsequent pasteurization was almost free from sedimentation of colloidal material. Of the several beverage formulations, plain carrot juice beverage, carrot pineapple blended beverage, carrot- orange blended beverage and carrot juice beverage flavoured with orange essence were found to have excellent sensory qualities. In addition, it was found that, incorporation of water extracts of four types of spice mixes enhanced the acceptability of carrot juice beverage. All these beverages remained acceptable for more than two months when stored at a temperature of 37°C. Total carotene retention was more than 90 percent at 37°C and almost 100 percent at 2°C during storage for 2 months.

FVP-12 STUDIES ON THE DEVELOPMENT OF CARROT TUTIFRUITI

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Carrots are one of the principal vegetable crops in India and an excellent source for Beta carotene, the vitamin A precursor and is reasonably a good source for most of the other vitamins and minerals. Hence, it is highly valued vegetable for consumption by both children and adults in some form or the other. Papaya tutifruiti (papaya candy) is extensively consumed throughout the country both as a confectionery item as well as for incorporation in bakery products and ice creams. Conditions were optimised for preparation of a similar product using carrots. The conditions were (1) cutting the tender carrots into pieces of 1.0 cm X 0.5 cm X 0.5 Cm (2) blanching the pieces in boiling water for 5 min. (3) soaking the blanched pieces in 0.5 - 1.0 percent calcium chloride solution and (4) going through the candying process till the sugar impregnation into the pieces was 68-70 percent. Total carotene losses during initial blanching of carrot bits were found to be around 4.5 percent which increased to 42 percent at the end of candying process. Total carotene content in the final product was still as high as 5 mg/100 g.

FVP-13 STUDIES ON EXTENDING THE SHELF-LIFE OF BER UNDER VARIOUS STORAGE ENVIRONMENTS

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In the present investigation, the ber fruits Cv.Umran were stored at room temperature (9.13 to 23.58°C and 28 to 74 percent RH), in zero energy cool chamber (14.50 to 18.32°C) and 91 to 95 percent RH) and cool store (4 to 6°C and 75 to 80 percent RH). It was found that, the shelf-life of ber fruits could be extended up to 18 days during storage in cool store followed by 10 days in zero energy cool chamber. However, the shelf-life of ber fruits was found to be only 6 days at room temperature.

FVP-14 DEVELOPMENT OF WHEY BASED BANANA BEVERAGE

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The present study was undertaken to formulate the *Paneer* and cheese whey-based banana beverage. Banana pulp was solubilized by hydrolysis of pectin using pectinase enzyme (Pectinex ultra) at 1 percent concentration (V/W), which resulted in 67 percent banana juice at 40°C after 2 h of incubation. The process for the manufacture of banana beverage involved clarification of whey, addition of sugar and banana juice and adjustment of pH. After bottling, the beverage was in-bottle pasteurized at 85°C for 15 min. Consumer acceptability trials were carried out with different levels of banana juice (20, 30, 40 and 50 percent) and pH adjustment to 4.5 and 5.0. Banana beverage having 20 percent banana juice, 73 percent *Paneer* whey and 7 percent sugar at pH 5.0 was most preferred by judges. Total solids, fat and protein content in banana beverage from both whey systems varied from 16.2-17.0 percent, 0.38-0.42 percent and 0.61-0.86 percent, respectively.

FVP-15 UTILIZATION OF RAW KARONDA FRUITS FOR PREPARATION OF PROCESSED PRODUCTS

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The raw (mature green) karonda fruits characterized with 74 percent moisture, 13.5° Brix, 2.81 percent acidity and 3.2 pH were utilized for making the products like jam, jelly and *chutney*. The raw fruits were boiled in water (fruit to water ratio of 1:1) till they broke open. The boiling water with juice was filtered and used for making jelly and residue was used for making jam and *chutney* after passing

through 1 mm mesh stainless steel sieve. All the products were organoleptically evaluated and found acceptable. The products could be successfully stored under ambient conditions for a period of one year. The products could be recommended for commercial exploitation of karonda fruits; about 90 percent of which goes as waste.

FVP-16 STUDIES ON THE UTILIZATION OF WASTES FROM APPLE PROCESSING PLANTS

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Studies were conducted at JKHPMC Apple Juice Concentrate Plant, Sopore to find out the percentage of processing wastes and to find out possibilities for utilization of such wastes. It was observed that, besides 25 percent apple pomace about 1.5 percent apple culls was discarded as belt rejection. Such fruit was successfully utilized for preparation of a homogeneous pulp after autoclaving the fruit at a pressure of 10 psi. The pulp so prepared was preserved with KMS at 1 gm/kg of pulp for a period of over one year. Ready-to-serve drinks (RTS) and squash prepared with 10 and 35 percent apple pulp, respectively, were judged as excellent beverages. Fresh apple pomace was used at 10.2 kg per day per animal as partial replacement of fodder in herd of 70 milching cows of Holstein Friesian breed without any deterimental effect on the animals. The average milk yield of animals remained uneffected. The average fodder expenses of about Rs. 18.5 per day per animal was reduced to about Rs. 7.0 per day per animal while feeding apple pomace as partial replacement of fodder.

FVP-17 CONCENTRATION OF TOMATO JUICE THROUGH REVERSE OSMOSIS

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The detrimental effect of heat on nutritional properties and flavour characteristics during concentration process can be overcome by adopting techniques that are based on principles other than the evaporation water. In this context, the membrane process, which allows removal of moisture to take place without much involvement of heat, has potential. Tomato juice prepared by hot break method using locally available commercial variety, was concentrated in a R.O. plant consisting of a plate and frame, cellulose acetate membrane with 1.02 m^2 effective area, high pressure reciprocating pump and a pulsating dampner. Optimum conditions for concentration of juice to 20° Brix were found out and effects of the concentration process on density, TSS, pH, acidity and viscosity were studied. Feed concentration exerted great control over rate of reverse osmosis. Permeate flux decreased exponentially with an increase in concentration factor under experimental conditions. The temperature of feed had a relatively smaller effect on permeate flux. The permeate

rate was more at high operating pressure and temperature and lower food concentration. The mass transfer coefficient and solute transport parameter decreased with an increase in the food concentration. Carbon weight factor of the boundary layer was more than the same in the bulk solution. Pore blocking factor increased with advancement in removal of cumulative water. Higher values for the pore blocking factor were obtained at lower operating pressures. TSS and acidity of the concentrate increased, whereas the pH decreased with increasing concentrations of feed. Operating pressure of 4.9 MPa and feed temperature of 30°C were found appropriate for the R.O. concentration of tomato juice to 20° Brix within the experimental limits.

FVP-18 SPECIFIC GRAVITY AND ITS INFLUENCE ON MATURITY OF MANGO cv. BANESHAN

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Mango fruit harvested at "Tapka" (when a few fruits fall naturally from the tree) stage having a specific gravity more than 1.00 is considered to have attained its optimum maturity. However, the majority of mature fruits of cv. Baneshan (86.4 percent) harvested at "Tapka" stage belonged to less than 1.00 specific gravity group. No clear relationship was observed between the fruit size, fruit weight and the specific gravity of this variety. Lightness of the fruit stone, low stone: pulp ratio (1:6.04) and a void space between the kernel and internal stone wall in Baneshan mango seemed to have contributed to this kind of specific gravity behaviour. The vascular vessels in the peel of Baneshan fruits were larger and present in greater numbers as compared to cv. Bombay Green and Surkha. Slightly better quality attributes were noticed in case of Baneshan fruits having more than 1.00 specific gravity.

FVP-19 EVALUATION OF GUAVA HYBRIDS FOR PROCESSING QUALITY

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Five hybrids viz., Hy.3-22, Hy.12-34, Hy.5-27, Hy.5-8 and Hy.11-7 developed at CCS Haryana Agricultural University, Hisar were evaluated for their processing quality and were compared with commercial cultivars L-49, Allahabad Safeda and Banarsi Surkha. The highest recovery of fruit pulp was obtained in Hy. 3-22 (97.24 percent), followed by Cv. Banarsi Surkha (97.14 percent) and Hy. 12-34 (97.02 percent), while it was lowest in Hy. 5-8 (94.86 percent). The fruits of hybrids contained high TSS, total sugars and reducing sugars, while acidity was lower in all the hybrids as compared to commercial cultivars. The Hy. 3-22 contained more pectin while Hy. 5-27 had higher ascorbic acid content. This showed that the hybrids were highly suitable for making various products and were rated no way less than the commercial guava cultivars.

FVP-20 COMPARISON OF GUAVA HYBRIDS WITH COMMERCIAL CULTIVARS FOR MAKING NECTAR, JELLY AND CHEESE

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Five guava hybrids (3-22, 12-34, 5-27, 5-8 and 11-7) developed at CCS Haryana Agricultural University, Hisar were evaluated at 30 days interval for making nectar, jelly, cheese and their shelf-life on storage for 90 days. Three commercial cultivars were taken for comparison. These products were prepared from winter season crops adopting standard procedure with slight modifications. High quality products were prepared from all the hybrids and were rated better than the products from commercial cultivars. During storage, there was a linear increase in browning, TSS, total sugars and reducing sugars, whereas ascorbic acid, pectin on storage. Acidity increased in nectar, while decreased in cheese and jelly during storage. The retention of quality parameters in storage was also higher in products prepared from hybrids as compared to commercial cultivars. The hybrids 3-22, 12-34 and 5-27 were found highly suitable for preparation of these products.

FVP-21 RETENTION OF ASCORBIC ACID DURING PROCESSING OF RAW MANGOES

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Raw mangoes which are utilized for the preparation of dry powder as an acidulant for curries, slices for pickles and chutneys are a rich source of ascorbic acid. The level of this vitamin in the preserved product is an indicator of the quality of product and the efficiency of the method of preservation or processing. Retention of ascorbic acid, tannins and acidity was found to be better in cabinet drying of slices as compared to sun drying. Similarly, cooking in steam was found to be a better practice for retention of their nutrients as compared to cooking in water. Similar trends were observed in slices steeped in KMS solution and curing in 10 percent salt as compared to 5 percent salt solution.

FVP-22 ESTIMATION OF VITAMIN C LOSSES IN LEMONS STORED IN MODIFIED ATMOSPHERE

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Lemons of variety "TAHITI" wrapped in PVC film, were stored at different conditions of temperature and relative humidity. Vitamin C contents were evaluated at certain intervals. One lot of lemons received a cold shock at -2°C for 2 h and the second lot received none before the storage.

A first-order reaction model was proposed and later validated by experimental data. The average value of the coefficient in the equation was related with relative humidity by a second order polynomial. The final model was found to be capable of estimating vitamin C loss as a function of storage conditions, film thickness, area of packaging and initial level of vitamin C. The model did a better estimation for the lot with cold shock.

FVP-23 BLENDED BEVERAGES FROM MANGO PULP

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Mango pulp being a rich source of carotene can markedly upgrade the colour of other beverages from fruits such as pineapple and apple which otherwise do not have an attractive colour. Thus, blending not only improves the quality and nutrition of basic raw material, but also offers scope for the development of newer products. In view of this, suitability and acceptability of mango blends with pineapple, apple, orange and plum fruits were evaluated. Mango pulp and other fruit juices were blended in the ratio of 0:4, 3:1, 2:2, 1:3 and 4:0, respectively and RTSB were prepared from these blends. Amongst, the blended nectar of mango with pineapple, apple, orange and plum, ratios of 2:2, 3:1, 3:1, 1:3 (mango and other fruits), respectively scored the highest in terms of sensory attributes. Blending of mango pulp with apple and pineapple markedly improved the quality of respective beverages.

FVP-24 COLOUR EVALUATION OF STORED TOTAPURI MANGO PULP BY COLORGARD SYSTEM

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Non-enzymatic browning is an important parameter for the quality evaluation of any stored fruit pulp or juice. However, the fruit pulps or juices when preserved with potassium metabisulphite (KMS), the application of this parameter does not provide reliable information as water soluble pigments are affected by this chemical. Studies on the evaluation of quality status of stored totapuri mango pulp in terms of its colour by colorgard system showed that the parameters like total colour difference (ΔE), saturation and hue can be taken as markers of quality in terms of colour. Pre-treatments such as addition of ascorbic acid, antioxidants, storing the pulp in dark and at low temperature were found to be better when evaluated by this method which was in conformity with the other methods of evaluation of non-enzymatic browning.

FVP-25 EFFECT OF SHRINK WRAPPING ON SHELF-LIFE OF POMEGRANATE

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Individual shrink wrapping of Pomegranate Cv.Ganesh, held at 8°C showed the maximum shelf-life of 70 days as compared to 20 days with wrapping and 15 days without wrapping at 25°C storage. The major changes during storage included the gradual decrease of respiration rate (100-20 mg/kg/hr) increase in weight loss to 16 percent and minimum changes in acidity, Brix, vitamin C and juice colour.

FVP-26 GAS-LIQUID CHROMATOGRAPHIC DETERMINATION OF BROMOPHOS RESIDUES FROM FRUITS AND VEGETABLES

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Bromophos (O-4-bromo-2,5-dichlorophenyl) O,O-dimethyl phosphorothioate) residue in cabbage (*Brassica oleracea* var. *capitata*), cauliflower (*Brassica oleracea* var. *botrytis*), tomato (*Lycopersicon esculentum*), Amaranthus spp., apple (*Malus domestica*), and grapes (*Vitis vinifera*) were determined by GLC with ECD. Steel column fitted with 5 percent SE-30 on Chromosorb-W 60/80 AW was used. The method was sensitive to 0.25 mg/50 g sample. Persistence studies conducted in the laboratory for 15 days revealed more initial residues in fruits (1.25 to 1.35 ppm) than in vegetables (0.93 to 1.0 ppm). The percent reduction in the residue in 15 days from the initial deposit was 42.2 to 50.0 percent in vegetables and 53.9 to 66.0 percent in fruits. Washing the vegetables with water removed 90.0 and 94.5 percent residue in cabbage and cauliflower. In apple, tomato and grapes 100.0 percent residues were removed.

FVP-27 EFFECT OF STORAGE ON THE QUALITY OF KINNOW FOR PROCESSING

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Kinnow mandarin is perishable and its harvesting period is also very short. Thus, kinnow mandarin was stored at ambient temperature (AT) (9-24°C) and refrigerated temperature (RT) (3.3°C) and evaluated for its processing quality in terms of physical and physico-chemical characteristics. The economic shelf-life of the fruits was 56 and 22 days at RT and AT, respectively based on 10 percent physiological loss in weight and spoilages. The juice yield was in the range of 46.11 to 49.07 percent. The total soluble solids (TSS), acidity and pectin of pomace; pectin and oil

of peel increased during storage. The TSS, pH, ascorbic acid, pectin, cloudiness and density of juice increased at RT, while acidity, ascorbic acid and viscocity decreased at AT. The sugars were not much affected by storage. The carotenoids and Hunter colour increased at RT but decreased at AT.

FVP-28 EFFECT OF PROCESSING ON PIGMENTS OF CERTAIN SELECTED VEGETABLES

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The objective of present study was to study the effects of thermal processing, pressure cooking and steam cooking in the presence of citric acid or sodium bicarbonate on pigments of certain selected vegetables. The measurement of colour was carried out in processed samples using reflectance spectrophotometry and correlating the data with sensory measures of colour. Results revealed that changing the pH of cooking media had substantial effect on betanins and chlorophyll, whereas beta-carotene and lycopene were only marginally affected. Heat treatments effected chlorophyll to a large extent, but between pressure cooking or steam cooking, variations were not encountered. Batch to batch variations were observed in certain pigments which were due to their levels of maturity and production variables. Sensory analysis of samples revealed a large variation in responses of trained panelists. There was a close correlation between instrumentally measured and visually analyzed colour parameters.

FVP-29 PRESERVE FROM COCONUT HAUSTORIUM

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Coconut is a major food crop contributing to a sizeable portion of agricultural income in all the developing countries. Studies were undertaken on preparation of preserve from coconut haustorium to get a good quality product which can help to diversify the product from coconut. Processing conditions for the preparation of perserve from coconut haustorium were standardised. Studies carried out have shown that coconut haustorium can be made into an excellent preserve. The preserve packed in glass jars remained in good condition for more than 6 months under ambient conditions.

FVP-30 **THE COLOUR DETERIORATION OF THE PROCESSED FRUIT PRODUCTS PACKED IN DIFFERENT PACKAGING MATERIALS DURING STORAGE**

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During storage of processed fruit products packed in different types of packaging materials, variations in colour deterioration was found. The colour variation of few fruit products packed in flexible laminate pouches, glass jars and cans were studied and methods to improve the colour retention were evaluated. The colours of the fruit products such as mango pulp, banana pulp and pineapple slices was found to be more brownish in flexible pouches and moderately brownish in glass jars as compared to tinplate cans. However, hydroxymethyl furfural or furfural, the index of browning was found to be slightly less in pouches and glass jars as compared to cans. Losses of carotenoid pigments were found to be more in flexible pouches as compared to other containers. To improve the colour in flexible pouches and glass jars, tin ions in the form of tin strips or tin granules were incorporated to mango pulp and packed. The presence of tin ions was found to reduce browning, keeping the tin concentration within permissible limits.

FVP-31 **DEVELOPMENT IN PROCESSING OF SPICES IN SRI LANKA**

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The spice trade has a significant impact on the economy of Sri Lanka. Spices are traded in various forms. About 90 percent is traded in whole form, while the balance consists of ground spices, spice oils and oleoresin. Cinnamon is native to Sri Lanka and is the oldest and still the most important of the island's spice industry. Quills, quill cut pieces, quillings, chips, leaf oil and bark oil are the important export products. The system of processing cinnamon into quills is unique to Sri Lanka and would appear to have been evolved through generations of collective experience. Cinnamon quills are prepared by peeling the stem bark of the coppiced shoots.

Pepper ranks second in production volume and export value among the spices exported by Sri Lanka. More than 95 percent of pepper produced in Sri Lanka is in the black form, which is the most popular in the international trade. Blanching is an improved technique used in Sri Lanka for preparation of black pepper. This treatment helps to get rid of molds and other microorganisms from the surface of the berries and quicker drying. Also, a uniform glossy black colour is imparted to the product. A longer shelf-life and better price is obtained for the pepper produced by this method.

FVP-32 ISOLATION OF PECTINS FROM MANGO PEELS

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Various factors governing the recovery and quality of pectin were studied to standardize the method for efficient recovery of pectins from mango peels. Among various extractants tried for isolation of pectins, 0.05 N HCl was the best for recovery of pectin from "Totapuri" mango peels. Optimum yield of pectin was obtained by taking two extractions each for one hour employing a peel extractant ratio of 1:2. Peels obtained from fruits of ripe, but firm stage gave higher yields of good quality pectin with high anhydrouronic acid (AUA), methoxyl content, degree of esterification (DE) and Jelly grade.

FVP-33 STORAGE STUDIES OF APPLE CV. RED DELICIOUS UNDER MODIFIED ATMOSPHERIC CONDITIONS

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Storage of fruits under modified atmospheric conditions and removal of ethylene from the storage environment, has been found to delay the senescence. With this in view, storage studies of apple cv. Red Delicious were conducted under two different situations viz., modified atmospheric storage and conventional storage, for a period of six weeks at ambient temperatures (17- 26°C). Modified atmosphere was created by packing the fruit in HDPE containers. Fruits in 2 kg were packed in each container along with 25 g ethylene scrubber. The scrubber was prepared by dipping coarse silica gel granules in potassium permanganate solution. The study revealed a percentage loss in fruit firmness and acidity to the tune of 24 and 16.6 in conventionally stored fruits as against 11.3 and 8.3 in modifed atmospheric storage, respectively. The physiological losses in weight amounted to 9.0 and 6.0 in conventionally and modified atmospheric storage, respectively. TSS registered an increase of 21.4 and 10.7 percent in conventional and modified atmospheric storage, respectively. Overall acceptability of the fruits under modified atmospheric conditions was better (7.5) than that of conventionally stored fruits (5.0).

FVP-34 OSMOTIC DEHYDRATION OF MANGOES/PINEAPPLES

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Mango dices (1 cm) of Alphonso variety were immersed in 62° Brix sugar solution (maximum Brix without heating). One batch was osmotically dehydrated at 50°C for 5 h and the other at room temperature for 24 h which was then followed by tray drying (TD) and fluidized bed drying (FBD). Studies on the stability of ascorbic acid and total carotenoids (TC) on these two batches were undertaken. Pineapple pieces (each ring of 5 mm thickness cut into 8) were osmotically dehydrated for 24 h followed by TD and FBD. Studies on stability of ascorbic acid and TC were carried out by packing them into plastic and laminated pouches. Percentage retention of ascorbic acid and TC in pineapples- laminated pouches were 2.68 and 6.24, respectively and plastic pouches were 2.02 and 4.92, respectively. The loss of fruit flavour by this method was less than only dehydration by regular methods and thus making it a good table snack.

FVP-35 EFFECT OF SOME PHYSICAL AND CHEMICAL PRE-TREATMENTS ON DRYING CHARACTERISTICS OF HASH-BROWN POTATOES

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Slow rehydration, brown discolouration and excessive breakage on handling are common problems associated with dehydrated potatoes such as hash-browns. In this experiment, attempts were made to increase the rate of drying so as to minimize these problems. Effects of some physical and chemical pre-treatments were studied. In the proposed process, Netted Gem (Russet Burbank) cultivar was selected. Potato shreds approximately (12.7-38.1) x 8x15 mm in size were pr-ecooked in $CaCl_2$ (200 ppm as Ca^{++}) solution, steam-cooked (10 min), dipped in glycerol (5 percent) and surfactant (0.1 percent) emulsion, and then dried in a fluid- bed dryer. The drying rate was found to increase through the extension of the constant-rate period and the total drying time was shortened to about 1 h. The product had lower bulk density of 0.15 g/cm^3 as compared to 0.31 g/cm^3 for a commercial sample. The colour of the product was lighter (L=75.4 Vs L=69.2) and breakage on handling was also reduced from 19.3 percent to 3.6 percent.

FVP-36 DEVELOPMENT OF METHODOLOGY FOR FLAVOUR PROFILING OF SPICE BLENDS AND ITS USE DURING STORAGE

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The role of spices and their blends as flavour enhancers in food systems is well documented. Spice blends are value-added products which are of diverse compositions. The need for their sensory analyses is obvious as they determine the functional quality of foods. Composite effect of individual flavour principles in spice blends can be effectively analysed by a trained panel. Four spice blends, *Garam masala*, *Chana masala*, *Pavbhaji masala* and *Panipuri masala* packed in PET bottles and stored under 3 different conditions viz., (a) High- 38°C; 90 percent RH (b) Accelerated-42°C; 30-40 percent RH and (c) Ambient-27°C; 65 percent RH were profiled to trace sensory quality changes over a period of six months. The profilograms drawn based on the differences from the control provide an immediate visual impact of changes. The results of the study will be useful to the food industry for fixing the pull-dates for national and international markets.

FVP-37 SNESORY COMPONENTS ANALYSIS OF IRRADIATED AND STORED SPICES

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The valuable sensory components of spices viz., colour, aroma and pungency were studied in four irradiated spices stored up to one year. Gamma irradiation at 10 KGy was carried out at BARC on whole spices and each spice analysed for specific component both in initial and periodical withdrawals. Chillies were tested for acetone extractable colour at 460 nm. Gradual lowering of colour was observed in both control and irradiated samples. Total capsaicinoid contents estimated by paper chromatography indicated that irradiation had not affected capsaicin content which was confirmed by pungency test by panel. Turmeric valued for colour, indicated no difference in initial reflectance spectra expressed in CIE system or even as curcuminoids by HPLC. The lowering of colour at the end of one year expressed as colour power measured at 423nm indicated similar pattern both in control and irradiated samples. Ginger is a very special spice with both pungency and flavour, hence estimation of both pungent compounds by TLC and flavour profile by a trained panel was carried out. No significant differences due to irradiation were seen in gingerol and shogaol contents. Flavour profile also showed a very closely matching pattern and complemented the GC finger print. The queen of spices, cardamom is valued for flavour and is profiled with trained panel. A similar pattern in control and irradiated sample profiles and GC finger printing confirmed that irradiation had not affected product quality. It can be concluded that no change occurs in sensory component of spices after irradiation.

FVP-38 SUITABILITY OF FLEXIBLE PACKAGES FOR PACKAGING OF MANDARIN ORANGE JUICE

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In recent times, mandarin orange juice is being packed in flexible pouches as well as 300 gauge high density polyethylene bags. A pilot scale study was carried out to find the effect of packaging materials, pH and processing on storage and quality of mandarin orange juice. The packages used were glass bottles, foil laminate pouches and 300 gauge polyethylene bags. Orange juice samples of pH 4.0 packed in the above packages were processed at 85°C for 25 to 35 min and subsequently stored for 90 days at ambient temperature. Changes in colour, flavour, taste, citric acid, pH, titrable acidity, TSS, reducing sugar, total sugar, non-reducing sugar, and ascorbic acid as affected by treatment were studied. Juice packed in foil laminate pouch was found to be at par with glass bottles with regard to spoilage. Processing for 30 min at 85°C was found to be adequate. Juice packed in foil laminate pouch retained maximum ascorbic acid after processing.

FVP-39 EXTENSION OF STORAGE LIFE OF RASTHALE BANANA UNDER MODIFIED ATMOSPHERE AT LOW TEMPERATURE

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In recent years, *Rasthale* variety of banana cultivation in Tamil Nadu State is increasing due to its excellent organoleptic qualities. Due to the growing consumer demands and in order to explore the possibility of this variety of banana for export to other countries, a study was undertaken to extend the storage life under modified atmosphere (MA) storage at low temperatures (13°C and 10°C, RH 80-85 percent). The studies indicated that the fruits harvested at 75 percent maturity could be stored under MA at 13°C in fresh and green condition upto 6 weeks and in ventilated pouches and in control (openly kept) upto 3 weeks. The percentage of CO_2 and O_2 during storage period upto 6 weeks in MA packs ranged from 3.8 to 6.35 percent and 15.7 to 11.8 percent, respectively. The stored fruits ripened normally at room temperature after treatment with 1000 ppm ethrel with good storage sensory quality. Physico-chemical changes in the fruit during storage and ripening were studied. The fruits stored at 10°C in MA developed chilling injury symptoms in 2 weeks. Hence, 13°C was found to be the optimum temperature for storage of *Rasthale* banana. The method standardised can find application in the transportation and storage of *Rasthale* banana for internal and export trade.

FVP-40 EFFECT OF MODIFIED ATMOSPHERE AT LOW TEMPERATURES ON THE STORAGE LIFE OF *NENDRAN* BANANA FOR MAKING CHIPS AND AS RIPE FRUIT

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Nendran variety of banana is used for making fried banana chips and as a table fruit in South India and Gulf countries. *Nendran* banana after harvest, starts to ripen and soften fast at room temperature (RT), making it unfit for fried chips. Due to the growing consumer demands for this commodity for internal and export purposes, a study was undertaken to extend its storage life under modified atmosphere (MA) at low temperature (10°C, 13°C RH 80-85 percent). The studies indicated that *Nendran* banana of 75 percent maturity could be stored under MA at 10°C in fresh green and firm condition upto 4 weeks as against 2 weeks in ventilated pouches and kept in open condition. The percentage of CO_2 and O_2 upto 4 weeks MA storage ranged between 2.9 and 3.2 percent and; 16.2 and 16.5 percent, respectively. The chips made out of the stored fruits were sensorily evaluated as "good". Storage beyond 4 weeks under MA at 10°C resulted in slight browning and hence inferior quality of the fried chips.

Nendran banana of 75 percent maturity stored under MA at 13°C kept well upto 6 weeks in fresh green and firm condition as against 3 weeks in ventilated pouches and kept in open condition without chilling injury (CI) symptoms and fungal infections. The fruits ripened normally at RT in 5 days after 1000 ppm ethrel dip treatment, with good sensory quality. The physico-chemical changes during storage and ripening were studied. Fruits stored at 10°C beyond two weeks failed to ripen normally, due to chilling injury. The above method of storage at low temperature can find application in chips making industry as well as to extend storage life for export by surface transport.

FVP-41 COMPARATIVE EFFICACY OF RIPENING INDUCERS ON THE RIPENING BEHAVIOUR OF *ALPHONSO* AND *TOTAPURI* MANGOES

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Alphonso and *Totapuri* mangoes during season find extensive demand by both processing industry and fresh trade. The fruits require nearly 8-12 days for ripening at RT. In order to achieve quick and uniform ripening and reduce wastage, several ripening inducers were tried, both at RT (27-30°C with 65-85 percent RH) and 37°C.

Alphonso mangoes treated with (a) calcium carbide, (b) 1000 ppm ethrel in hot water (c) smoking (d) vapour heat, followed by exposure to ethylene gas and (e) ethylene gas 1000 ppm as such ripened in 6-8 days with 5 to 7.5 percent PLW and 0.4 percent spoilage, while control fruits ripened in 12 days with 10.4 percent PLW and 24 percent spoilage at RT. *Totapuri* mangoes exposed to smoking and calcium carbide, ripened within 5 days at R.T., while those exposed to ethylene gas and ethrel in hot water ripened in 7 days and control ripened in 11 days. Percentage PLW in treated fruits ranged between 3.3 and 7.5 percent as against 10.4 percent in control on 11th day.

At 37°C, treated *Alphonso* and *Totapuri* mangoes ripened 2-3 days earlier than RT stored fruits with similar trend of ripening. The sensory quality of all the treated mangoes of both the varieties at both the temperatures was good. Hence, ripening inducers like (a) dip in hot ethrel solution and (b) exposure to calcium carbide, are easy methods suited for large scale operations. Smoking treatment which is gradually being replaced by ethrel dip is also equally effective and can find application in the industry to get early uniformly ripened *Alphonso* and *Totapuri* mangoes with minimum spoilage.

FVP-42 EXTENSION OF SHELF-LIFE OF *ALPHANSO* AND *TOTAPURI* MANGOES OF KARNATAKA UNDER DIFFERENT METHODS OF STORAGE

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Alphonso and *Totapuri* mangoes of commercial harvest maturity grown in Karnataka, were given (a) pre-treatments with calcium chloride, gibberellic acid, cold shock and along with control were stored at 13°C, (b) without pre-treatments as mentioned under (a), stored in dry (28.7°C) and wet saw dust (26°C), (c) evaporative cool chamber (21-22°C with 90-95 percent RH), (d) RT (28-30°C, RH 60-75 percent and (e) MA at 13°C. Results indicated that fruits of both varieties subjected to pre- treatments did not show enhanced shelf-life effectively as compared to control fruits at 13°C.

Alphonso mangoes stored in dry and wet saw dust and E.C. chamber had a storage life of 13, 17 and 17 days with 10.3, 3.9 and 4.2 percent PLW, 4.0, 20.0 and 0 percent spoilage, respectively. The overall sensory quality of the above fruits was rated good as compared to 11 days of storage life for control fruits stored at R.T. which had 9.5 PLW, 20 percent spoilage and fair sensory quality. Fruits under MA conditions (3.5-4.5 percent CO_2 and 5.5-8.0 percent O_2) at 13°C could be stored well for a period of 24 days with 1.0 percent PLW and 80 percent marketability as against 21 days life of control fruits which had 5.2 percent PLW and 80 percent marketability beyond 24 days although MA stored fruits remained green and firm, developed off- taste and CO_2 injury and did not ripen uniformly after removal to RT. *Totapuri* mangoes could be stored well with 5.2 percent PLW and 80 percent maraketability in E.C. chamber upto 17 days as against 10 days with 9.0 percent PLW and

82 percent marketability for control fruits at R.T. Sensory quality of the E.C. stored fruits was very good after 17 days compared to fair quality of control fruits after 10 days.

AT 13°C, control as well as MA packed *Totapuri* mangoes had a shelf-life of 25 days with 7.1 and 2.4 percent PLW and 80 percent marketability, respectively. The sensory quality of MA stored fruits was comparable to control fruits. Fruits stored beyond 25 days under MA developed CO_2 injury. It was concluded that for internal trade/short term storage of *Alphonso* and *Totapuri* mangoes where refrigerated facilities are not available, EC storage and wet saw dust storage methods can be applied. MA storage at 13°C was not found beneficial for prolonged storage of both the varieties of mangoes as against conventional low temperature storage at 13°C.

FVP-43 STUDIES ON THE PREPARATION OF QUICK COOKING BITTERGOURD CURRY MIX

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Bittergourd (*Momordica charantia*), a vegetable of culinary and medicinal importance is consumed throughout the Indo-Pakistan sub-continent as a fresh vegetable. In this work, an attempt was made to standardise conditions for the preparation of quick- cooking bittergourd curry mix traditionally known as "*Gojju*" which is a sweet, sour and spicy curry. Dehydrated bittergourd was prepared by hot air drying to be used as curry- mix along with suitable amount of spice mix. Pre-treatment of bittergourd with 5 percent sodium chloride for 30 min gave a product with satisfactory rehydration qualities. Packaging and storage studies were also carried out on the product. Moisture sorption studies revealed that a moisture content of 12.5 percent (on dry wt. basis) was critical with respect to crispness. The calculated monolayer value was 5.4 percent (dry wt. basis) which indicated the minimum moisture content that could be attained for minimising physico-chemical deteriorative changes in the product. The results showed that polypropylene for bittergourd and metallised polyester/PE for spice mix were found to be suitable as packaging materials for a shelf-life of about 3 months at room temperature when packed in the bag-in-bag package.

FVP-44 EFFECT OF ADDITIVES ON THE STORAGE STABILITY OF MANGO AROMA CONCENTRATE AT DIFFERENT TEMPERATURES

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The storage behaviour of aroma concentrate from *Alphonso* mango was studied at RT (26-28°C), 2°C and -18°C in the presence or absence of certain additives. The additives used were

glucose + glucose oxidase + catalase system, sodium sulphite and ascorbic acid. It was noticed that aroma constituents underwent changes during 2 months storage period at room temperature, leading to the loss of typical aroma profile. Constituents like esters, carbonyls, alcohols and oxygenated terpenes etc, showed lower values during storage. Even in the presence of additives, the stability was enhanced only by a month. In contrast to this, aroma concentrates stored at 2°C, were stable for a period of 6 months without additives and upto 10 months with additives. At - 18°C, they were stable for 12 months even without additives.

FVP-45 EFFECT OF ROASTING OF SPICES ON RETENTION OF ACTIVE PRINCIPLES DURING STORAGE

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Roasting of spices is an important step in preparation of spice- mixes. It is a common observation at home as well as in food industries that spice-mixes have very short shelf-life. Therefore, an attempt was made to find out the causes for the losses of active principles in spices such as Chilles, Coriander, Cumin and Pepper.

Fresh chillies (with colour-450nm 6 OD/g, oleoresin 19.9g/100g and capsaicinoids 250mg/100g) after roasting (colour 5.3 OD/g, oleoresin 17.1g/100g and capsaicinoids 249mg/100g) although developed a desirable aroma, lost some pungency (0-10 percent) and an appreciable amount of colour (12-56 percent) during storage in glass bottles for 4 months at 37°C. On the other hand, deseeding of whole chillies before roasting to get chillies pericarp (initial values before and after roasting, colour 7.2 and 6.5 OD/g, oleoresin 10.5 and 9.5g/100g and capsaicinoid contents 374 and 276mg/100g respectively), although lost some pungency (26.2 percent) during roasting of pericarp, retained the initial pungency of roasted chillies to a significant extent (92- 100 percent) during storage for 4 months at 37°C. Due to opening up of whole chilli fruit, loss of capsaicin during roasting of deseeded chillies was appreciably higher (20 percent) compared to loss of capsaicin during roasting of whole chillies (0-5 percent). The study indicated that roasting of whole chillies followed by destalking and deseeding might reduce the losses of active principles during storage.

Other spices such as coriander, cumin and pepper showed minor changes in the active principles during roasting (initial values, before and after roasting; coriander E 251.5nm-1.20, 1.20 OD/g and oleoresin 25.2, 25.7g/100g; cumin E 252.5nm-16.3, 16.3 OD/g, and oleoresin content 27.0, 28.2 g/100g; and pepper E 337.5nm- 98.4, 98.4 OD/g and oleoresin content 12.0, 12.2 g/100g), lost the active principles to some extent (0-9.9 percent) during storage in glass bottles for 4 months at 37°C. It was inferred from the study that loss of pungency and colour in spice-mix may be reduced by deseeding and destalking of roasting chilli.

FVP-46 STORAGE STABILITY OF INSTANT SPICED *VADI*

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"*Vadi*" is one of the traditional product of Indian dietary which is normally prepared from Bengalgram/*urad dhal* flour by mixing with salt and spices followed by sun drying. *Vadi* though highly popular, is difficult to cook needing 25-30 min boiling in water and seasoning. Secondly, cooking of fresh vegetables at high altitude poses tremendous problems and therefore quick cooking *vadi* containing vegetables will be highly desirable to meet the requirements of troops deployed in snow-bound areas. Therefore, an attempt was made to develop a nutritionally balanced *vadi* composition containing carrot, bottlegourd, potatoes and Bengalgram flour which reconstitutes in boiling water in 3 min. The vegetables after cooking were kneaded with Bengalgram flour and spiced and formed into spherical balls and dried at 70°C. The dried *vadis* were blended with hydrogenated oil, salt and spices mix and packed in polypropylene and paper-aluminium foil-polyethylene laminated (PFP) pouches which were stored at room temperature and 37°C for evaluation of storage stability. Instant spiced *vadi* contained protein 10.7 percent, fat 23.9 percent, ash 5.85 percent and moisture 3.2 percent. Instant spiced *vadi* remained stable for one year in PFP pouches. The changes in peroxide value, free fatty acids, thiobarbituric acid, total carotenoids and sensory changes taking place during storage were studied.

FVP-47 EFFECT OF WATER ACTIVITY ON MICROENCAPSULATED CARDAMOM OIL

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Precooked dehydrated convenience foods are widely used in operational pack rations of Armed Forces. Changes in flavour due to oxidation/evaporation is the most frequent cause of rejection of dehydrated convenience foods. Use of microencapsulated flavours have proved highly effective in minimising the flavour alterations. The processing conditions for microencapsulation of cardamom oil were optimised by spray drying method. Effect of water activity on the retention of microencapsulated cardamom flavour was investigated. About 90.1 percent cineole and terpenyl acetate, 91.6 percent borneol, 87.8 percent pinene and 84.4 percent p-cymene were retained below 0.6 a_w upto 30 days storage. Storage above 0.7 a_w caused collapse of microencapsule and loss of volatiles. The efficacy of microencapsulated flavour in instant halwa mix was studied *vis-a-vis* mix containing cardamom powder. After 6 months of storage at 37°C about 80.2 percent cineole and 82 percent terpenyl acetate was retained in *halwa* mix containing microencapsulated flavour, while the sample containing cardamom powder retained 52 percent cineole and 45 percent terpenyl acetate when packed in polypropylene film.

FVP-48 STUDIES ON DEVELOPMENT, ACCEPTABILITY AND STORAGE STABILITY OF INSTANT CARROT *HALWA*

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Convenience foods are widely used by Armed Forces and have been found very useful especially during combat operations. For inclusion in operational pack ration, these foods ought to meet certain minimum requirements such as light in weight, palatablity, wholesome and easy to reconstitute. Carrot *halwa* is a highly popular product and is also energy dense. Therefore, attempts were made to develop instant carrot *halwa*. The process consisted of shredding, pressure cooking and drying of carrots, subsequently blending with milk solids, sugar, *vanaspati* and flavourings. Instant carrot *halwa* reconstitutes in boiling water in 5 min. It scored an overall acceptability rating of 8.0 on a nine-point Hedonic scale. Instant carrot *halwa* mix had a moisture 2.2 percent, protein 9.12 percent, fat of 23.3 percent, total ash 2.52 percent, acid insoluble ash 0.29 percent and sugar 44.5 percent. Storage stability of carrot *halwa* was evaluated at ambient temperature and 37°C in polypropylene (75 U) and paper (45 GSM) - aluminium foil (20 U) - polyethylene (37.5 U) laminate packs. During storage, PV, FFA, TBA and browning increased, whereas total carotenoids and overall acceptability scores decreased. Taking overall acceptability score of 7.0 as minimum limit for acceptance, instant carrot *halwa* remained stable for 6 months in PFP and PP packs. Development of hay-like odour was the major cause of spoilage during storage.

FVP-49 FLEXIBLE PACKAGING FOR LIQUIDS AND SEMI SOLID FOODS

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The objective of this study was to develop a suitable packaging system based on flexible packaging materials for lemon squash and condensed milk. These products were packed in low density polyethylene/nylon/low density polyethylene; polypropylene/nylon/polypropylene; low density polyethylene/ nylon/ionomer; metallised polyster/high density/low density polyethylene were evaluated at ambient (19°C-30°C) and accelerated conditions (37°C; 90 percent RH; and 40°C). Storage was carried out for 12 months. In the case of lemon squash, no significant changes in chemical profiles were observed. Polypropylene/nylon/polypropylene was found to be suitable packaging material for 8-9 months of storage. In condensed milk also, no significant changes in chemical profiles, except development of undesirable colour, were observed. Only metallised polyester/high density/low density polyethylene was found to be suitable packaging material for condensed milk for 6- 7 months of storage.

FVP-50 CONVENIENCE FORM OF RAW CARROTS AND THEIR PRESERVATION BY REFRIGERATION

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The role of minimal processing was investigated on the extension of shelf-life of raw carrots. Cleaning, peeling, cutting, grating with or without treatment with acid and salts fall into the purview of minimal processing. Raw carrots were packed in different packaging materials for refrigerated storage. Changes in moisture content, total carotenoids, acidity, sodium chloride, microbiological quality and texture and overall quality were determined during storage. Total carotenoids remained unaffected due to any of the treatments. NaCl increased to 1.3 percent and remained constant for 3 months. Titratable acidity increased considerably (from 0.03 to 0.35 percent) and gave a pH of 3.7. Psychrophilic microbial activity was low. Moisture content decreased from 89 to 80 percent and loss in turgor occurred in whole carrots without packing in 6 days, and in precut packed carrot in one month. Due to surface washing and cleaning, microbial concentration was reduced marginally, but by several log numbers due to acid-salt treatment remained constant for 2-3 months. Spoilage (fungal/bacterial), was not visible for 15-20 days in whole carrots, for 2 months in carrot sticks and for 7 days in grated carrots. Packing with additive solution led to rapid spoilage compared to samples packed after complete draining. Colour and texture remained good in cut carrots for 7 days (control) and for 2-3 months in acid-salt treated ones. A combination of minimal treatments was useful in extending shelf- life of raw carrots in the desired form.

FVP-51 CHEMICAL AND MICROBIOLOGICAL STUDIES ON REFRIGERATED FRESH CABBAGE AFTER MINIMAL PROCESSING

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Fresh cabbage is damaged outwardly during transportation and there is considerable wastage. To avoid such losses and to enable storage of large quantities during excess production as well as to provide convenience to the consumer, the effect of minimal processing technique was examined. Whole cabbages were washed, drained and packaged in a flexible packaging film. Some cabbages were shredded, treated with citric acid and salt and packaged. Treated and control samples were stored at 5-7^{o}C for varying periods. Changes in moisture, chlorophyll, salt and acid contents, sensory parameters and microbiological contents were negligible. Chlorophyll degradation occurred in control samples, but their texture was superior to treated samples. Microbial counts were initially lowered considerably by acid-salt treatment, but during storage, bacteria, yeasts and molds increased more rapidly than in control samples, reaching the level of 10^{8}/g in 75-90 days. Untreated control samples developed browning after 45 days as well as a stale taste. Treated samples displayed acceptable sensory characteristics upto 115 days of storage. Whole unshredded cabbages suffered moisture losses when uncovered and developed browning characteristics sooner

than the shredded samples. The study showed that shredded cabbages without any treatment could be refrigerated in packaged form for upto 30 days and upto 90 days with treatment.

FVP-52 STUDIES ON THE CONCENTRATION OF MANGO AND GUAVA JUICE BY REVERSE OSMOSIS

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Investigations were carried out on concentrations of mango and guava juices using a Lab Model Reverse Osmosis (RO) unit and membranes. The juices obtained by enzyme clarification of pulp could be concentrated from 15° to 27° Brix for mango and from 9° to 24° Brix for guava with membrane types CA-992, HR-95 and HC- 50. Average permeate flux at 50 bar operating pressure were found to be 13 to 15 L/m^2/h for mango and 12 to 16 L/m^2/h for guava juice depending on the membrane. Losses of acid, reducing sugars and ascorbic acid varied with the three membrane types. Sensory evaluation showed the juice concentrates to be comparable in acceptability to the feed juices. Storage studies showed that mango juice concentrate with 500 ppm sulphur dioxide packed in polypropylene pouches (110 cm^2 with 70 g juice) and pasteurized in boiling water (temperature attained at the cold point 85°C) for 1 min was acceptable upto 6 months at RT and 4 months at 37°C.

FVP-53 DRYING OF FRESH CORIANDER LEAVES BY SOLAR COOKER AND PRODUCT ACCEPTABILITY

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Fresh corrinader leaves occupy a place of speciality in Indian cookery, but are not available round the year. In the present study, fresh leaves (250 g) were separated from stalk and throughly washed with distilled water and divided equally into 4 lots. The time taken for drying in direct sunlight and shade at 38°C (Max. atmospheric temp.) was 6 h and 3 days, respectively, while the time taken in box type solar cooker was 2 h and 3 h in containers with and without lid in this cooker. Regarding nutritive value, the ascorbic acid content decreased from 123 mg/100 g in fresh coriander leaves to 86.3 and 85.7 mg/100 g, when samples were solar and sun-dried, respectively. The iron content decreased from 17.3 mg/100 g in fresh leaves to 9.4 and 9.9 mg/100 g, respectively. Solar-dried samples were highly desirable in aroma, colour, texture and appearance as compared to sun-dried coriander leaves.

FVP-54 SHELF STABILITY OF MINIMALLY PROCESSED FRESH GREEN CHILLIES

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Green chilli is a minor, but important component of our food and is relished in the raw, as well as preserved form. To minimize physical damage, microbiological spoilage and extend the shelf-life of green chilli, different minimal treatments were considered. Washed whole chillies were treated with (a) citric acid and common salt and (b) salt, mustard, vinegar and oil (as salad dressing). Packed in polypropylene flexible pouches, samples were stored at ambient temperature and 5°C and periodically examined for microbiological and chemical changes and compared with untreated stored control samples. Acid-salt treatment affected reduction in microbial concentration (by 2 log numbers) and chlorophyll and capsaicin contents by 10 and 3 percent, respectively. Acidity increased marginally as a result of treatment (a). After 2 months of storage, chlorophyll degradation ranged between 7 percent (control) and 20 percent (treated); capsaicin content was reduced by 15.6 percent (control) and 19.4 percent (treated). Total microbial counts increased to 10^7-10^8/g. At ambient temperatures, treated and untreated chillies were spoiled in 3-4 days. With treatment (b), samples were found to be stable for 11 months (5°C) and 6 months (ambient temperature). Microbial counts during this period increased by 1-2 log numbers. The study indicated that, the acid-salt treatment extended the shelf-life of green chilli at 5° by 2 months, whereas coating in a salad dressing gave it a shelf- life of 6 months without refrigeration and 11 months at 5°C.

FVP-55 STABILISATION OF COOKED FRENCH BEANS AT ROOM TEMPERATURE

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The work on fully pre-cooked French beans (*Phaseolus vulgaris*) was undertaken, with a view to provide a vegetable component to a shelf stable intermediate moisture curry concentrate. Pre-cooked cut beans were treated at room temperature with different levels of acid and/or salt at atmospheric pressure and under vacuum. Such acid-salt infused beans were partially dehydrated to a pre-determined moisture content expected to be compatible with the curry concentrate. Packed in polypropylene (PP) and paper-aluminium foil- polyethylene (PFP) laminated pouches, such samples were stored at ambient temperature (30°C$\pm$2°C) and at 37°C. Changes in acidity and salt contents, chlorophyll content, taste and odour profile of stored samples were evaluated periodically. Chlorophyll content was degraded to the maximum during cooking and subsequent acid treatment and thereafter, it stabilised during storage. Acidity and salt levels were within palatable limits. There were no significant changes in other parameters when these samples were stored in PP and PFP pouches for 180 days both at 30 and 37°C. There was no apparent microbial spoilage in such samples. Such beans were instantly rehydratable along with curry concentrate, when the latter was diluted using only warm water (70°C).

FVP-56 STORAGE BEHAVIOUR OF DRY SPICE MIXES CONTAINING DESICCATED COCONUT OR COPRA

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Spice mix formulations were developed for the preparation of "*Mustard coconut bhath*". One mix had desiccated coconut in the formulations, and the other had copra. The samples were packed in metallized polyster-poly and a special three film pouch (nylon-polypropylene- polyethylene) and stored at 27°C; 65 percent RH and 37°C; 95 percent RH. Samples were drawn periodically and analysed for moisture, free fatty acids and acceptability. Samples stored at 38°C; 95 percent RH showed an increase in moisture content upto 3 months and the moisture pick- up was more in samples containing desiccated coconut. Similar trend was observed in the formation of free fatty acids during storage. Samples with desiccated coconut had a free fatty acid content of 1.2 percent after 3 months of storage under both conditions. Rice *bhath* preparations made using stored samples showed that over a period of 6 months, the spice mix containing copra was preferred to the sample containing desiccated coconut, indicating that desiccated coconut would not show any advantage over copra gratings in the preparaton of ready-to-use mustard coconut mix.

FVP-57 ELECTRON SPIN RESONANCE STUDIES IN IRRADIATED SPICES

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Radiation preservation of spices is being used for complete decontamination from microbes which helps in preventing post- harvest losses. The radiation preservation of spices is commercially being accepted by Government of India. However, so far, there is no suitable method developed to detect irradiated foods. The development of such detection method will boost the commercialisation of food irradiation technology. In the present study, the possibility of using Electron Spin Resonance (ESR) to detect free radicals, formed after irradiation, was explored. The ESR spectra of fifteen different spices were recorded after irradiation with different doses and also at different time intervals of storage upto 6 months, along with control. It was found that, in all the cases irradiated samples showed higher intensity of signal than the unirradiated ones. However, the intensity decreased on storage of samples. The studies indicate the applicability of ESR technique for detection of irradiated spices.

FVP-58 PREPARATION OF GINGER RTS FLAVOURED WITH MINT AND TULSI EXTRACTS

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Aqueous extraction of juice from ginger was made and ready-to- serve (RTS) prepared in sugar solution by mixing ginger juice in different proportions (2,4,6,8 and 10 percent). The addition of 4-6 percent ginger juice in RTS was acceptable. Total soluble solids (TSS) was fixed at 11.5°B in the product. Selected combinations of 4 and 6 percent additions of ginger juice (without and after clarification) were prepared in bulk and bottled in 200 ml capacity for determining the stability of the product. The pH of the product decreased and acidity of the product increased with storage period. The product was also evaluated organoleptically. Although, the scores for flavour, texture and mouthfeel decreased after 12 months of storage, they were in the acceptable range. The addition of mint and tulsi in ginger RTS improved the colour, flavour, taste and mouthfeel scores of the product.

FVP-59 ALPHA-MANNOSIDASE OF *CAPSICUM ANNUUM* L.

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Alpha-mannosidase from capsicum was purified to homogeneity by gel filtration on Sephadex G-100, followed by ion-exchange chromatography on DEAE-Sephadex A-50, which was further purified by HPLC-gel filtration. The HPLC fraction was 100 percent pure and gave a single band on native PAGE. The purified enzyme showed a molecular weight of 43,000. It had a broad pH curve with an optimum activity at pH 5.7. The temperature optimum was 50°C and at 70°C for 5 min., the enzyme retained 50 percent of its activity. Its K_m for p-nitrophenyl alpha-D mannoside was 0.7 mM. It was free of endo beta-mannanase activity. Fe^{2+} and Cu^{2+} showed an inhibition of 95 percent at 0.1 mM levels, while the other metal ions did not affect its activity. It was not inhibited by mannose, glucose and galactose. The enzyme was found to be the most prominent protein in capsicum (>80 percent). It is quite possible that alpha-mannosidase has a major role in mannan degradation in capsicum which was previously found to be a significant carbohydrate polymer undergoing solubilization *in vivo* during ripening. Also, endo beta-mannanase activity was not in detectable levels in this system. The alpha-mannosidase activity monitored from raw to ripe stage, showed an increased activity at the climacteric stage, which was chosen for purification. This enzyme was implicated in fruit softening in tomato, a phenomenon related to fruit shelf-life.

FVP-60 UTILIZATION OF RAW *KARONDA* FRUITS FOR PREPARATION OF PROCESSED PRODUCTS

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The raw (mature green) *karonda* fruits characterized with 74 percent moisture, 13.5° Brix T.S.S, 2.81 percent acidity and 3.2 pH were utilized for making products like jam, jelly and chutney. The raw fruits were boiled in water (by taking water in 1:1 proportion) till they broke open. The boiling water with juice was filtered and used for making jelly and residue was used for making jam and chutney after passing through 1 mm mesh stainless steel sieve. All the products were organoleptically acceptable and could be successfully stored under amnbient conditions for a period of one year. The products could be recommended for commercial exploitation of karonda production about 90 percent of which goes as waste.

FVP-61 MORPHOLOGICAL CHARACTERISATION OF LARGE CARDAMOM VARIETIES BY SOFT X-RAY IMAGE ANALYSIS

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Large cardamom, *Amomum subulatum*, generally grown in Sikkim, is a preferred spice in many dishes of Northern and Eastern parts of India. Broadly, the large cardamom has five varieties, depending on morphological features. The chemical analyses of these varieties do not show much differences. Cardamom varieties were subjected to non-destructive soft X-ray and the radiographs were imaged using Soft X-Ray ISTV-25 and Sigma-II analyser. The morphological parameters showing characteristics of each variety were seed inter-space, shape of seed and number of seeds per capsule. Location of oil inside the seeds also varied in different varieties as determined by X-ray density pattern. Soft X-ray studies revealed that most of the varieties of large cardamom were susceptible for lassioderma infestation, whereas *Madhusay* variety is relatively more resistant. Soft X-ray radiography seems to be a rapid, non- destructive technique of characterisation of large cardamom.

FVP-62 GAS BARRIER POLYMERIC FILMS FOR MODIFIED ATMOSPHERE PACKAGING OF FRESH FRUITS

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Modified atmosphere package parameters i.e. fill weight, film surface area for gas transmission and free volume within the package, were derived from mass balance equations based on respiration

rate of the fruit and transmission rate of gases through the film at different gas concentration gradients between outside and inside atmosphere of the package. Packets of pre- determined sizes were prepared from gas barrier polymeric (GBP) films i.e. Saranex-15, 11, 8 and BOPP-50, 40, 25. Packets were filled with known quantities of fresh apple fruits (Cv. Red Delicious) and sealed with Impulse sealer for storage at 5, 12, 22 and 30°C along with control samples. Gas samples from packages were analysed by gas chromatograph. Textural profile parameters were determined on Instron machine. 0-9 Hedonic scale was used for sensory evaluation. Control samples were rated far below the fruits sealed in GBP film packets, except for Saranex- 15 packets where peel discolouration and flesh softening started after 45 days (12°C) due to high CO_2 (12-22 percent) and low O_2 (<1-3 percent) concentrations. Weight, volume, peel colour and flesh firmness were retained very close to those of fresh apples upto 130 days (22°C) and 180 days (12°C) in BOP-50 and 40 packets, while mouthfeel attributes were rated slightly higher for BOPP-25 packets.

FVP-63 AN INTERMEDIATE MOISTURE FOOD FROM PAPAYA

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Intermediate moisture foods (IMF) are obtained from fruit pulps or *purees* by evaporation of water and addition of certain preserving agents like sugar , salt, etc, so as to bring down their water activity (a_w) in the range of 0.7-0.8. Papaya which is cheaply available throughout the year, can be easily converted into an IMF. Water activity and moisture content relationship were determined using static method of determination and stability analysis done using BET and GAB models. GAB models fitted better than BET and provided lower value of stable moisture content for papaya pulp. Amount of sugar added and water to be evaporated was optimized taking a_w, final product weight and unit cost of production as the criteria for optimization. Addition of 0.34 Kg sucrose per Kg papaya pulp along with removal of 0.71 Kg of water per Kg pulp gave a product of thick consistency and attractive golden yellow colour with a slight reddish tint. The overall appearance of the product was similar to fruit jelly. Unit cost of the product was found to be Rs. 28.68 per Kg.

FVP-64 EFFECT OF SEMPER FRESH (SUCROSE ESTER) COATING ON STORAGE BEHAVIOUR OF PLUM VAR. *SANTAROSA*

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Fruits of plum var *SANTAROSA* were harvested at commercial maturity stage and divided into two lots, one was dipped in (0.8 percent) semper fresh coating solution for a period of 5 min, and the other was dipped in water (control). The fruits were air- dried under fan at room temperature, for about 20 min, and kept under ambient temperature (25±3°C) to monitor storage changes. The

initial TSS of the plum was 7.0° Brix which increased to 7.6- 7.7 ° Brix in both treatments during first week and thereafter the TSS decreased more drastically in control (6.6 °Brix) as compared to 7.3°Brix during 21 days storage. There was a decrease in percentage malic acid (MA) from 1.81 to 1.27 in control as compared to 1.81 to 1.52 in treated samples. The CPLW (percent) was more in control group fruits, 23.7 in comparison to 21.5 in coated samples. The subjective textural properties were maintained up to 13 days in control, as compared to 18 days in treated samples. The study indicated beneficial effects of semper fresh coating in reducing the moisture loss, maintenance of sugar and acid in treated samples, as compared to control. Further, the cosmetic appeal and textural properties were maintained better in treated samples.

FVP-65 **STANDARDIZATION OF PRETREATMENTS FOR DEHYDRATION OF PEAR HALVES VAR, *ANJOU***

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The sun-dried pear halves produced traditionally without any pre- treatment lack consumer appeal due to discolouration and fungal contamination. Investigations were carried out to optimise the pre-treatments to overcome these defects. The pears were washed, cored and trimmed. The unpeeled halves were dipped in treatment baths consisting of T1(water control); T2(KMS 1 percent + 0.25 percent citric acid), T3 (KMS 1 percent + 0.5 percent citric acid); T4(KMS 2 percent + 0.25 citric acid); T5(KMS 2 percent + 0.5 percent citric acid); T6(KMS 3 percent + 0.25 percent citric acid) and T7(KMS 3 percent + 0.5 percent citric acid). The pear halves were dipped for a period of 60 min in treatment baths with fruit to solution ratio 1:2. The treated lots were dried under sun and in mechanical drier at 60±2°C. The dehydrated products were packed in polyethylene bags (150 gauge for studying quality parameters during storage. The fresh pear had moisture (percent) 85.23, TSS(°Brix) 12.4, and acidity percent malic acid (MA) 0.31. The preparation losses were 8.81-17.61 percent. The sun-dried samples took about 20 days to achieve 12.04 to 13.61 percent moisture level. Analysis of the dried halves for various characteristics showed that moisture (percent) ranged from 8.88 to 11.60; acidity (percent MA), 0.93 to 1.86; dehydration ratio 5.52 to 7.25; and rehydration ratio 1.62 to 1.88. The sensory evaluation rated the products from T4 to T7 treatments superior than control, with respect to colour, flavour, and taste attributes, and maintained the quality parameters over a prolonged period of more than one year under ambient storage conditions without microbial spoilage.

FVP-66 EFFECT OF EVAPORATIVE COOL STORES ON SHELF-LIFE AND QUALITY OF MANGO cv *LANGRA*

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Mango cv. *Langra* is one of the choicest table varieties in India. Low shelf-life and quick spoilage are the major impediments for its distribution. Evaporatively cooled stores viz., small zero-energy cool chamber (one quintal capacity) and its bigger version (one ton capacity) with provision of ventilation were developed at IARI, New Delhi to meet the demands of on-farm storage of fruits and vegetables. Storage study of mango cv. *Langra* was conducted in both chambers by giving treatments viz., pre-storage spray (mist) with 1000 ppm Bavistin (Benzimidazole), bagging in HM-film (High molecuar high density polyethylene film of 25 μ thickness) with or without Bavistin and control The temperature and relative humidity recorded during experiment were 24±2°C and 96±2 percent; 27±2°C and 88±2 percent in small and big chambers, respectively. A uniform ripening and better post-harvest quality in terms of Brix-acid blend, aroma, texture, low rotting and high carotenoids were observed in the fruits stored in the big chambers. The climacteric peak was delayed and electrolyte leakage was checked by bagging the Bavistin treated fruits in 25 μ HM-film bags. Therefore, the shelf-life could be extended from 7 days at ambient to 12 days in evaporatively cooled store by keeping the Bavistin treated fruits in HM-film bags.

FVP-67 EVALUATION OF TOMATO CULTIVARS FOR JUICE PREPARATION

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Heat treated (75-80°C for 5 min) tomato juice of cultivars, *Pusa Ruby, Selection-18, Pusa Early Dwarf, Money Maker, Marglobe, NT-3, Century, Hissar Arun* and *Ratna* filled in 250 ml glass bottles were processed by immersion in boiling water for 20 min without preservative and stored at room temperature (32-35°C) over a period of 90 days in order to screen the most suitable cultivar for juice making. The cultivar *NT-3* yielded the maximum juice (83.3 percent), followed by *Hissar Arun* (78.6 percent) and *Marglobe* (76.5 percent). However, no cultivar showed its supermacy in all chemical characters, i.e., TSS, acidity and ascorbic acid. The highest TSS (6.2 percent) was recorded in *Marglobe*, while acidity (0.64 percent) and ascorbic acid (36.18 mg/100 ml juice) were maximum in *Money Maker*. The analysis of juice at zero day revealed that *Pusa Ruby* contained non-significantly higher TSS (8.6 percent), and acidity (0.38 percent) than other cultivars, while ascorbic acid (19.80 mg/100 ml juice) was significantly lower than *Money Maker*. The TSS increased and acidity decreased with extended period of storage. The maximum TSS (9.8 percent) and acidity (0.34 percent) were recorded in *Pusa Ruby* after 90 days of storage. Ascorbic acid content of juice

varied with cultivar and period of storage. Juice samples of all the cultivars were free from yeasts and molds, but *Micrococcus* spp. was found during storage. In organoleptic rating, *Pusa Ruby* secured the maximum score reflecting its suitability for juice preparation.

FVP-68 **LOW ALCOHOLIC BEVERAGE AND TOFFEE FROM BER (*ZIGYPHUS MAUSITIANA*)**

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Ber fruits are of hardy nature and have a short shelf-life. These fruits possess good percentage of edible portion (80 percent pulp) with 10-12 percent sugar. However, the pulp is sticky with mucilage and the use is restricted. A low alcoholic beverage was prepared from the ber fruits. The product was free of mucilage and had good storage stability. The beverage had agreeable colour (clear), flavour (pleasant) and taste. Similarly, the freshly prepared toffee from residue (edible pulp) was found comparable to "Parle Kismi Toffee Bar" with respect to taste, colour, flavour and texture. The product stored for 3 months at room temperature was hard, hence chewing was difficult.

FVP-69 **PRESERVATION OF TROPICAL *PLEUROTUS* MUSHROOMS**

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Pleurotus mushrooms are one of the poorest genera for canning in simple brine, because the caps are thin and as they are cooked in the brine, they lose their texture and become quite unpleasant in appearance and often discoloured. An attempt was made to preserve fresh *Pleurotus* mushrooms by soaking for a definite period of time in different solutions of sugar or salt or acids in different concentrations or mixtures of sugar, salt and acids in different proportions, and then boiling for only 5 min. in the same solution and packing in hot condition in sterile polypropylene packets. The main advantages of the method are longer period of storage and lesser risk of damage during transport. From the results, it was evident that the solution containing mixtures of sugar, acid, salt and metabisulphite of definite proportion gave the best result.

FVP-70 EFFECT OF OXYGEN CONCENTRATION IN STORAGE ATMOSPHERE ON RESPIRATION RATE OF APPLE FRUIT

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Respiratory behaviour of apples (Cv-Red Delicious) in terms of oxygen (O_2) uptake pattern of the fruit along with their quality attributes, was studied for 57 days starting from 10th day after harvest (157 days after flowering), in atmospheres containing O_2 concentration of 20.8, 16.0, 11.0, 5.0, 3.0 and <1 percent in nitrogen with 77 percent R.H., at a temperature of 5, 10, 20 and 30°C each. Rectangular shaped, air tight containers made of 6 mm thick acrylic sheet, fitted with service ports were used for respiration study. Changes in O_2 levels in containers' atmosphere were measured at 24 h intervals while CO_2 and ethylene were continuously absorbed. Oxygen uptake increased by 7.6 times with increase in temperature from 5 to 30°C in 20.8% O_2, while in <1% O_2, the increase was only 1.4 times and in 3% O_2, it was 4.6 times. The increase in O_2 uptake rate with increase in temperature (5-30°C) was reduced significantly in 3 to 5 percent O_2 from that of 20.8 percent. In the neighbourhood of climacteric peak, the O_2 consumption rate in 3 percent O_2 was 1/5th to 1/7th of that found in 20.8 percent O_2, within 5 to 30°C. In 20.8 percent O_2 at 20 and 30°C, there was sharp climacteric rise, followed by steep fall in O_2 uptake rate, while in low O_2 of 3-5 percent, flat climacteric peaks followed by slow and gradual decline in O_2 uptake rate which later remained nearly constant were observed. Fruits in <1 percent O_2 at 20 and 30°C developed tainted flavour and suffered from onset of discolouration. Fruits kept at 5°C in 3 percent O_2 retained highest firmness, while fruits kept at 5°C in 5 and 11 percent O_2 were rated higher during sensory evaluation.

FVP-71 NATURAL FOOD COLOURANT: TURMERIC

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The toxicity of synthetic food colours and restrictions on their use have increased the importance of natural food colours. Turmeric is widely used in food without any restrictions. However, its characteristic flavour profile is inherent and is undesirable, especially when it is to be used as a food colourant. Agmark standard grade turmeric powder was extracted with alcohol in Soxhlet apparatus. The essential oil from the extract was separated using liquid-liquid extraction treatment and the colouring principle, curcumin was precipitated with excess water. This solution of curcumin suspension was sprayed and dried over carriers such as sugar and starch in a fluidized bed drier. The colourant was tested in food systems like *shrikhand* and custard and was evaluated by sensory analysis. The natural colour from turmeric was found to be comparable with synthetic dye, tartrazine and the flavour was completely undetectable.

FVP-72 SUN DRYING OF TOMATOES

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A simple method of drying was experimented for household level, during summer months, when tomatoes were in glut and extermely cheap, with a maximum day temperature of 46°C, prevailing during mid May-June. The variety selected was one that had more pulp and less juice and commonly available. The red ripe tomatoes were washed with 5 percent solution of potassium permanganate and sliced into 1/4" thick slices using a stainless steel knife. These were spread on polythene sheet/aluminium tray slightly smeared with oil, spreading each slice individually. This was covered with a muslin cloth and kept in sun. After about 2 h, the sides of the slices were turned. For the next 4-5 days, the slices were kept in the sun, and dried till crisp and finally grinded in an electric grinder. The mixture was stored in air tight container and use as and when required around the year.

FVP-73 A SIMPLE LOW-COST SELF-COOLING STORAGE CONTAINER FOR FRESH FRUITS AND VEGETABLES

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A simple self-cooling container was designed and fabricated based on evaporative cooling principle using slip casting technique for the preservation of fresh fruits and vegetables. The design consisted of earthern jacketed wall filled with water all around having openings at the top and bottom for free exchange of gases. The water was filled through the inlet provided at the outer wall.

In the experiments, oblong shaped 4 litre capacity containers having water holding capacity of 1.5 liters in the jacketed walls were designed and fabricated. Experiments were carried out to know the cooling efficiency of the container at different temperature and relative humidities in the environment. It was found that cooling efficiency was very high at higher temperatures and very low relative humidities. The design also maintained a very high relative humidity inside the container which prevented the transpirataion losses in fresh fruits and vegetables. Trails were conducted on mature green tomatoes purchased from the local market. Tomatoes were packed in earthern container with water, without water and the control were kept at 27°C and 65 percent RH. The control tomatoes spoiled after 15 days and tomatoes kept in container without water was spoiled after 20 days. The tomatoes which were kept in container with water was in good condition upto 35 days.

FVP-74 EFFECT OF BLANCHING ON YIELD, COMPOSITION AND QUALITY OF OUTENGA (*DILLENIA INDICA*) JUICE

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Ripe Outenga (*Dillenia indica*) fruit is difficult to process for juice recovery due to its very hard texture, high fibre content and presence of gummy substances. Application of pectinolytic enzymes was not found to be encouraging for increased recovery of juice. When the fruit sepals were separated and reduced in fruit mill and the juice was pressed out by screw press, the yield of juice was very low (25 percent). There was, however, no appreciable change in colour and quality of the juice. In order to facilitate processing and enhance recovery of the juice, the Outenga sepals of the fruit were blanched for 2, 3, 4, 5 and 6 min. in boiling water. When blanched for 6 min., the yield of juice was increased to 41.7 percent. With increase in the blanching time, there was a consistent increase in the contents of acidity and reducing sugar, while ascorbic acid, TSS and pectin content decreased significantly. When the juice was recovered without any blanching, it contained 0.832 percent acidity, 3.0 mg/100 g ascorbic acid, 2.17 percent reducing sugar, 14.5 percent TSS and 2.58 percent pectin, which on blanching of cut sepals for 6 minutes increased to 1.25 percent and 3.70 percent for acidity and reducing sugar, respectively, and decreased to 1.2 mg/100 g, 8.0 percent and 1.10 percent for ascorbic acid, TSS and pectin, respectively. However, blanching had no significant effect on the organoleptic quality of the juice.

FVP-75 ENHANCHMENT OF STORAGE LIFE OF ASPARAGUS UNDER MODIFIED ATMOSPHERE USING SILICONE MEMBRANE AND CALCIUM CHLORIDE TREATMENT

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The storability of green Asparagus dipped in 4 percent calcium chloride ($CaCl_2$) solution with surfactant and thickener kept at 1.5°C for 28 days under RA, HRA and MA conditions were assessed and compared. MA conditions were maintained with silicone membrane installed as windows on laboratory scale containers. After 28 days, there was no significant difference between $CaCl_2$ dipped and control, with regard to texture and storage loss. Calcium dipped MA stored Asparagus showed better colour visually; chromometer "Lab" values were towards purplish shade. The silicone membrane windows were able to adequately control CO_2 levels, but regular diffusion tubes of various lengths were required to maintain the desired levels of 3 percent O_2. From the data obtained, it was not possible to conclude on the utilization of $CaCl_2$ for long term storage of Asparagus due to severe

contamination of soft rot during storage. However, the colour of the $CaCl_2$ dipped MA stored Asparagus, indicated the possibility of better storage over control, provided soft rot contamination could be controlled.

FVP-76 **UTILISATION OF LESSER YAM (*DIOSCOREA ESCULENTA*) AND AERIAL YAM (*DIOSCOREA BULBIFERA*) TUBERS**

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The yam like other root or tuber crops are essentially starchy or carbohydrate in their composition. Attempts were made to prepare some Indian fast food snacks like yam vegetable, yam *vada*, yam *bhaji*, yam *bonda* and yam vegetable cutlets from fresh tubers of *Dioscorea esculenta*. The products were acceptable in their seasony attributes, with yam vegetable having a maximum overall quality score (8.21) followed by yam *vada* and yam *bonda* (7.39 each) on a 9 point hedonic scale. Similarly, another neglected species of yam from the processing point of view is that of *Dioscorea bulbifera*. This was used to prepare products like boiled, roasted and baked yam; fresh yam chips from fresh tubers and some dehydrated products like dried yam chips, yam rava, yam flour, yam (flour) ice cream. All these products, except for dried fried yam chips were acceptable in their sensory attributes, with yam ice-cream having a maximum overall quality score of 7.43, followed by boiled and baked yam (6.57 each). Thus, the lesser yam and aerial yam tubers could be successfully utilized for making different edible produts.

FVP-77 **STUDIES ON THE DEVELOPMENT OF MUSTARD GREEN (*BRASSICA CAMPESTRIS*) PICKLE**

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Studies were carried out on the development of mustard green pickle. The basic ingredients included mustard green tender shoots, salt, rye, turmeric and chilli powder. Increase in the concentration of salt from 5 to 15 percent restricted the development of lactic acid during storage at room temperature. Acid development improved flavour and overall acceptability of the product. Considering the development of acid and organoleptic characteristics of pickle, 10 percent salt was found to be optimum. The addition of acetic acid and mustard oil markedly increased the shelf-life and acceptability of the mustard green pickle.

FVP-78 STUDIES ON EXTRACTION OF JUICE FROM POMEGRANATE FRUIT

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The present investigation was undertaken to study the various methods of extraction of juice from pomegranate fruit Cv. Ganesh. It was found that the juice extraction method using crushed pomegranate grains heating to 40°C gave maximum juice recovery (60.21%), with an adequate quantity of anthocyanins, sugars and comparatively lower tannins; which recorded the highest score during organoleptic evaluation.

FVP-79 STUDIES ON THE PREPARATION OF PROCESSED PRODUCTS FROM SQUASH AND THEIR EVALUATION DURING STORAGE

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Squash (*Cucurbita maxima*), a rich source of Beta-carotene, vitamin-C and carbohydrate was used for a variety of food preparations such as flour, ketchup and chips. The data on processing of squash flour revealed that the drying ratio ranged from 4.8:1 to 6.2:1, while the milling loss was to about 12-15 percent. The quality attributes indicated that the sample treated with 1 percent sodium metabisulphite was evaluated as the most acceptable sample for fresh as well as after 3 months storage in high density polyethylene bag filled with nitrogen gas. The microbial count by accelerated aging process was also noticed to be under safe level. The squash ketchup had better quality attributes when tasted fresh. However, after 3 months storage, it exhibited significantly superior quality and thick consistency than the fresh product. The data on quality and acceptability of deep fat fried squash chips indicated that among different treatments (0.25, 0.50 and 1.0 percent) of sodium metabisulphite dip solution, 0.50 percent treatment showed significant results for colour, taste, flavour and crispness. The storage studies for 3 months in high density polyethylene bag with nitrogen gas revealed that the product was found to be the most acceptable without any trace of rancidity or spoilage.

FVP-80 STUDIES ON EXTENDING POST-HARVEST SHELF-LIFE OF MANGO

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The mango (*Mangifera indica* L) cultivar Keshar was subjected to different post-harvest dip treatments of NAA (100- 200 ppm), GA (125-250 ppm) and cool water (15±2°C) to study the ripening behaviour during storage at ambient (28+2°C) and cool chamber (18±2°C) conditions with and without low density polyethylene bags of 4 percent diffusion holes. Among the samples stored at ambient conditions with LDPEB, the control and cool water dip treatment fruits started ripening on 8th day and attained fully ripe stage within 12 days, while the NAA and GA treated samples continued ripening upto 20th day. However, the fruits without LDPEB showed faster rate of ripening in the above samples. Under cool chamber conditions, the fruits placed with LDPEB exhibited onset of ripening on 12th day in control and water dip treatments, while in NAA and GA treated samples, the ripening was initiated on 20th day and continued even after 28th day. However, the samples without LDPEB had initiated ripenig 4 days earlier than the above samples. The microbial spoilage (rotting) and physiological loss were found to be significantly higher in control (50 and 11 percent, respectively) and cool water dip fruits (60 and 9.6 percent, respectively) placed at the ambient conditions without LDPEB. The fruit colour index, CI-2, light green and the fruit firmness index, slight hard was noticed in most of the fruits placed under cool chamber conditions. The total soluble solids (°Brix), titratable acidity (percent citric acid), total sugars, reducing sugars and carotenoids were found to be accumulated at a slower rate in the samples placed under cool chamber than the ambient storage fruits. The results indicated that, the mango fruits treated with 100-200 ppm NAA and 125-250 ppm GA stored in cool chamber in LDPEB with 4 percent diffusion holes remained in good condition upto 28 days after harvest.

FVP-81 CHARACTERISTICS OF ETHYLENE PRODUCTION DURING RIPENING OF 'CARABAO' MANGO

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Ripening of mango is characterised by a series of changes such as physico-chemical, physiological, biochemical which determine the post-harvest shelf-life of the fruit. Studies on ripening of 'Carabao' mango revealed that the events of softening, colour development, respiration, total

sugars, total soluble solids, starch, carotenoid content and titratable acidity showed marked changes. The associated changes noticed were of increased production of ethylene (measured by using Varian gas chromatograph Series 1400) in the different tissues (inner and outer mesocarp and peel) as indicated by the peaks during ripening. A greater sensitivity of the inner mesocarp to the ripening action of ethylene was evidenced by early ripening changes in the inner mesocarp than in the outer portions of the fruit. In the regulation of ethylene biosynthesis in "Carabao' mango, 3 major enzymes, ACC synthase (protein of the dialysed enzyme extract analysed using the Lowry method), ethylene forming enzyme and malonyl Co-A transferase were found to be involved in the ripening process. Further, the results indicated that low levels of ACC due to lesser activity of ACC synthase resulted in low ethylene production throughout the ripening period.

FVP-82 STUDIES ON ULTRAFILTRATION OF GRAPE JUICE

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In order to prevent browning and sedimentation in golden yellow coloured grape juice of "Dixie" variety, preservation of juice in frozen condition with or without sulfitation and ultrafiltration were tried. In general, ultrafiltration using 10,000 molecular weight cut off (mwco) to 1,00,000 mwco membranes reduced the amount of sediments in the juice by removing phenolic compounds and sedimentation during storage was lowest due to ultrafiltration using 10,000 mwco membrane. Non-enzymatic browning was higher leading to brownish yellow colour when juice was preserved in frozen condition without sulfitation. Addition of potassium metabisulphite (200 ppm of SO_2) helped in retention of golden yellow colour of the juice.

GRAIN SCIENCE TECHNOLOGY

GST-1 QUALITY OF GRAINS SOLD IN CENTRAL BUSINESS AREA AND RESIDENTIAL AREAS OF MYSORE CITY - A CASE STUDY

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Assesment of quality of grains sold in the various business zones of a city would exhibit the type and quality of grains made available to the consumer and consequently exposure to health hazards. Rice, Wheat, Ragi, Bengalgram, Greengram, Horsegram, Redgram dhal, Bengalgram dhal and Blackgram dhal were purchased from central business area (CBA) and five different residential areas (RA). Procurement was done at the beginning of the first, second, third and fourth week of a month. They were subjected to kernel damage, wt/vol, viability and uric acid tests. Results indicated that at CBA, the quality of all the commodities varied through a month in a definite pattern, i.e., a gradual decline in the quality from first week to the fourth week and showed a cyclic pattern was observed. However, in RA, definite pattern was observed as seen in CBA. Those commodities with a high turnover rate had better quality each week and those with low turnover rate showed deterioration in the quality every week. Presence of uric acid was positive for all the commodities studied in all the business areas under study.

GST-2 PHYSICO-CHEMICAL PROPERTIES OF BAMBOO (*BAMBOO ARUNDINACEA*) SEEDS AND ITS STARCH

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Bamboo (*Bamboo arundinacea*) seeds, commonly called bamboo rice, resemble wheat or rye grain of smaller size in appearance. The plants flower once in their life time (25 to 50 years) and the grains are collected by tribals for edible purpose, cooked and eaten as rice after hand pounding. The dehulled grains contain about 11 percent protein and 1 percent fat (d.b). The milled (debranned) grains contain 9.5 percent protein, 0.5 percent fat and 81 percent starch of which, 27.3 percent was amylose. Starch from milled rice was isolated and characterised in terms of viscographic behaviour, iodine binding capacity, number average molecular weight and gel permeation chromatographic profile. It resembled rice starch in almost all respects.

GST-3 FORCE-DEFORMATION BEHAVIOUR OF URD GRAIN (*PHASEOLUS MUNGO* L.)

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The compression tests of Urd (variety MAS 218) were performed to determine the various characteristics such as modulus of elasticity, toughness/hardness, load index and energy consumption in horizontal and vertical positions. The grain sample was divided into four sample size: small (2.5-3 mm), medium (3-3.5 mm), large (3.5-4 mm) and above large (4-4.5 mm), so as to correlate various rheological properties with milling characteristics of the grain. The studies were conducted at different moisture levels viz., 7, 9, 12 and 16 percent (wb). All characteristic parameters increased linearly with grain size except toughness. The energy required for splitting or rupturing the grain increased with increase in grain size. The ideal conditions for milling were observed to be (i) force required to crack the grain (47.04 N), (ii) energy consumption (92 Joules), (iii) deformation (0.3732 mm), (iv) moisture content 9.0 percent (wb) and (v) deformation rate 5 cm/min. The energy required for milling the grain varied considerably with grain size.

GST-4 PRETREATMENT METHODS TO IMPROVE COOKING QUALITY OF SOME DRY LEGUMES

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Studies were carried out to improve the cooking quality of dry rajma, lobia and field beans using pretreatment methods involving soaking in different salt solutions and cooking at different pressures prior to hot air dehydration. Cooking time could be reduced by 60 to 70 percent by soaking, water blanched rajma in sodium chloride (2 percent), sodium bicarbonate (0.75 percent) and sodium tripolyphosphate (1 percent) solution and blanched lobia in sodium bicarbonate (0.75 percent) solution for 6 h prior to cooking in open steam for 10 min. and 5 psi for 5 min., respectively. To get similar effect, dry field beans required 15 min blanching, prior to soaking in sodium bicarbonate (0.5 percent) and sodium tripolyphosphate (1 percent) solution for 8 h followed by dehydration. Alternatively, soaking unblanched rajma and lobia in tap water for 6 to 8 h before cooking at 10 psi for 10 min. and 5 psi for 5 min., respectively, gave a comparable cooking quality. Butterflying of rajma (25 percent) and field beans (15 percent) could be reduced to below 5 percent level by soaking, cooked beans 1 h in 20 percent sugar solution.

GST-5 STUDIES ON IMPROVING THE NUTRITIONAL QUALITY OF "MASA" - A TRADITIONAL NIGERIAN FERMENTED FOOD

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Masa (*Waina*) is an yeast fermented puff batter of millet or rice baked on a pan with individual cup-like depressions. It resembles *idli* in shape and *dosa* in taste. Nearly 80 percent of the Northern Nigerian population derive the bulk of their protein and energy needs from millet or rice based *masa*. Since it is a single cereal food, its protein is of poor nutritional quality. Studies were conducted to assess the feasibility of supplementing millet/rice with grain legumes for *masa* preparation. Based on the least cost computer programme, *masa* formulations were prepared using rice/millet blended with cowpea and peanut. The nutritional qualitites of *masa* prepared from rice/millet alone, rice-cowpea, rice-cowpea-peanut, millet-cowpea and millet-rice-cowpea blends were evaluated by rat feeding trials. Among them, rice and millet single cereal *masa*, and rice *masa* were found to be superior to millet based one. Supplemented *masa* was nutritionally better than those made from millet or rice alone. Supplementation did not adversely affect either the texture or the sensory qualities of *masa*.

GST-6 PREPARATION AND NUTRITIONAL EVALUATION OF SOME TRADITIONAL FOODS FROM PEARL MILLET

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Pearl millet (*Pennisetum typhoides*), an important food crop, remains under-utilized for human nutrition. An attempt to incorporate the pearl millet in some traditional food preparations was made. *Chapati*, *Khichdi*, *Bakli*, *Dalia*, *Shakkarpare*, popped grains and cake made from pearl millet were acceptable to human palates. Bran contained a major portion of phytic acid and polyphenols of the grain, which were lowered by heat treatment. The protein and starch digestibilities of the food products were significantly higher than those of raw grains; boiling had the most pronounced effect. Debranning enhanced *in vitro* availability of calcium, iron and zinc significantly vis-a-vis reduction in phytic acid and polyphenols. Levels of phytic acid and polyphenols also negatively affected protein and starch digestibilities. Some of the products have highly desirable nutritive value and scope for their use in mitigating malnutrition.

GST-7 DEVELOPMENT AND QUALITY EVALUATION OF WEANING FOOD FORMULATIONS

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Locally available raw materials viz., wheat, jowar, bajra, maize and Bengalgram seeds were taken for studying their malting characteristics and also to find out the suitability of these malts in the preparation of weaning food formulations. These malts and their blends (cereal malt : pulse malt, 2:1) were evaluated for microbial load and sensory characteristics. The blend of malts from wheat and Bengalgram was found more acceptable with respect to colour, flavour and taste, followed by blend of malts from jowar and Bengalgram. Other blends of malts from maize and bajra were also comparable and found suitable for use in weaning food formulations. With regard to rheological properties, these blends were more or less in the optimum range of viscosity required for preparation of weaning food formulations.

GST-8 PHYSICO-CHEMICAL AND NUTRITIONAL QUALITIES OF SORGHUM AND MILLETS BASED EXTRUDED WEANING FOODS

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Sorghum, pearl millet and finger millet were milled in Ross experimental roller mill, and each of the debranned flour (60 percent) were blended with toasted green gram (30 percent) and skim milk powder (10 percent). The blends were equilibrated to 18 percent (dwb) moisture and extruded at 140°C barrel temperature and 160 barrel rpm in a single screw Brabender extrusion cooker. The overall expansion ratio for sorghum, pearl millet and finger millet extrudates were 1.3, 0.9 and 2.3, respectively. The foods had acceptable taste, aroma, and crunchy texture. They exhibited high cold paste viscosity. The protein contents of sorghum, pearl millet and finger millet extruded foods were 15.5, 17.4 and 12.0 percent and the lysine content of the proteins were 4.93, 4.82 and 5.54 percent, respectively. Nearly 75 percent of the lysine was in the available form. Extruded foods contained higher levels of soluble dietary fibre than their native blends. The PER, BV and TD of pearl millet and finger millet foods were 2.38, 85.6, 82.4 and 2.55, 89.3, 79.6 respectively, indicating that the protein quality of the foods was adequate for weaned infants.

GST-9 FORMULATION AND IMPROVEMENT OF WEANING FOOD MIXES SUITABLE FOR ASSAMESE CHILDREN

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Four weaning food mixes based on expanded rice, malted green gram, malted Bengalgram, *athiyakal* variety of banana and dehulled and toasted sesame were formulated. The foods contained about 12 g protein and about 380 calories per 100 g. The calorie density of the foods was about 0.6 K cal per ml slurry and this was raised to 1.2 K cal per ml of slurry by addition of 10 percent finger millet malt to the formulations. The sensory scores for colour, texture, consistency and overall acceptability were high for all the formulations and among them the scores for banana containing formulation were highest. The foods were well accepted and tolerated by the weaned infants, restoring normal growth without any gastro-intestinal disorders. The formulations packed in HDPE pouches stored at 30°C and 70 percent RH remained acceptable up to 45 days. The studies established the prospects and potential of using expanded rice, a readily available ready- to-eat rice product and Assamese variety of banana in development of low cost weaning mixes.

GST-10 DISINFESTATION OF RICE BY GAMMA-IRRADIATION

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Studies involving two varieties of export quality rice namely "Pari" and "Lal Qilla" that were artificially infested by adult *Tribolium castaneum* and *Sitophilus oryzae*, have shown that gamma irradiation in doses of 0.5 kGy and above leave no surviving insect after 40 days of experimental period. Percentages of weight loss due to infestation of the grains by these insects suggested that 1.0 kGy is the preferred dose for the control of these two important storage pests. Experiments with the variety "Pari" have shown that irradiation at 1.0 or other lower doses of 0.5 and 0.25 kGy do not effect some of the cooking and eating qualities like length and volume expansion of cooked rice grain. Water absorption on cooking of rice and alkali-digestibility of uncooked rice are also not affected by irradiation but slightly reduces the gel consistency of uncooked rice.

GST-11 PARBOILED SORGHUM - A NEW BASE FOR SOME TRADITIONAL INDIAN FOODS

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A dry heat parboiling method involving soaking whole sorghum in hot water, followed by roasting at 200°C was standardised. Laboratory milling of such processed sorghum to remove about 8 percent bran showed that, pearling was more uniform in the cone polisher [whiteness value (wv) 20 percent] than either in barley pearler (wv 18 percent) or McGill mill (wv 15 percent). Commercial cone polisher (2 passes) also yielded well pearled (wv 20 percent) grains. Both hard and soft endosperm sorghums gave similar results on parboiling and pearling. Parboiled sorghum semolina (-20 + 45 BSS) gave *idli* of acceptable quality. Sorghum *idli* had bulk density and viscoelastic firmness values of 0.76 and 22.5 percent as compared to 0.81 and 22.9 percent for rice *idli*, respectively. Sorghum flour (-60 BSS) gave excellent *dosa* (pan cake) and crisp *chakli* (fired snack) with 3 percent shortening. Fried sorghum flakes had higher (4.5) expansion ratio than rice flakes (3.0). Thus, parboiled sorghum can be used as a cheaper substitute for rice in some traditional preparations.

GST-12 EFFECT OF MOIST-HEAT TREATMENT ON MILLING OF ARHAR

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Preliminary studies on pre-treatment with grains of "T-7" variety of *arhar* revealed that thermal and /or moisture conditioning influenced both dehusking and breakage whereas oil application reduced breakage in milling of arhar. Therefore, grains of "BR-65" variety of arhar of 3.35-4.00 mm size having 86.5 percent cotyledons, 12.4 percent husk and 1.1 percent germ were heated in live steam for short periods of about 10 min. which raised their moisture content by about 10 percent and then dried to 11-13 percent moisture content at 40-45°C. The moist heat-treated grains were held for about 16 h in air-tight containers. This cycle was repeated once and the pre-treated grains were subjected to abrasive milling in Satake Testing Mill (Model TM-05) which provided quantitative dehusking of grains in a single pass of about 10 sec. The yields of up to 84.8 percent head dhal (98 percent of theoretical yield) with less than 3.0 percent brokens + germs + scourings, and 12.3 percent clean husk indicated the efficacy of this pre-treatment in milling of size- graded arhar grains.

GST-13 RICE PROCESSING IN BANGLADESH

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Rice is the most important crop in many Asian countries including Bangladesh. The processing of paddy to rice is a business which in total is worth more than 1000 million US dollars every year. If only a small proportion of this could be diverted to the poor, the impact would be considerable. This poster attempts to do this and includes the use of small scale hullers; the development and use of an improved parboiling unit; modifications to post- harvest equipment; and research on vacuum parboiling.

GST-14 EFFECT OF OKARA INCORPORATION ON EXTRUDED PRODUCT QUALITY

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The combinations of soy-cereal blends viz. flours of corn, soybean and okara were used for extrusion under similar conditions. Extruded product containing rice and corn in higher proportions showed higher expansion ratio, lower solid density (0.25 g/ml) and higher water uptake compared to samples of okara or a mix containing okara. Maximum expansion ratio of 2.95 was obtained for rice; soymix (90:10). Harder product with higher solid density of 0.5 g/ml was obtained with okara as the sole ingredient. The product indicated its suitability for production of semi-cooked extruded products. Rice or corn flour combined with soyflour could give a product quality acceptable for production of ready-to-eat snacks. Okara, however, can be used for production of semi-cooked products. Incorporation of soybean and okara into cereal-based extruded products would be useful in nutritional and protein quality improvement.

GST-15 QUALITY IMPROVEMENT OF *IDLI* USING EXTRUDED RICE GRITS

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The effect of substituting rice with extrusion cooked (75°, 100° and 125°C) rice grits in a C.W.Brabender laboratory extruder at 10, 20, 30 and 40% levels on the quality of *idlis* was investigated. Both the levels of substitution and temperature of extrusion had significant effect on

the specific gravity, activity and pH of the *idli* batter, and textural and sensory qualities of the *idlis*. The *idlis* prepared from *idli* mix containing rice substituted by 20-30% of rice grits extruded at 125°C were most acceptable.

GST-16 VISCOAMYLOGRAPHIC CHARACTERISTICS OF RICE FLOUR AND ITS EFFECT ON FOOD PRODUCTS

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Rice (*Oryzae sativa*) flours from six cultivars were studied for proteins, lipids, starch, amylose, water holding capacity, hydration power and amylography. Besides differences due to variety and amylose content, the particle size of the flour greatly influenced the pasting characteristics of the flour and gel consistency of the cooked paste. Viscoamylographic studies of the flours of 307, 214, 165, 138, 114, 90 and 71 μ indicated that the flours of 138 and 165 μ showed high breakdown ratios of 0.984 and 0.866, and set back ratios of 2.333 and 2.143, respectively, indicative of the ease of cooking and retrogradative changes, which are important criteria for their use in gluten-free rice-based pasta products. The flours of particle size of 214 and 307 μ had comparatively lower gelatinization and this property was made use of in the preparation of snack foods which required crispy texture. The flours of 114, 90 and 71 μ showed low breakdown ratios of 0.746, 0.814, 0.811 and set back ratios of 1.873, 1.928 and 1.898, respectively, and they imparted desirable soft texture to puddings and desserts. The differences in the textural properties of food products were shown to be directly related to the inherent properties of the particle size of the rice flour and not to the cultivar. Rice flour had diverse combinations of physico-chemical and viscoelastic characteristics. These can be made use of in the preparation of different food products.

GST-17 STUDIES ON SHELF-LIFE OF SNACK PRODUCTS MADE FROM BAJRA

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Bajra is a very nutritious millet, though it contains highest concentration of fat among major cereals. It is not being used in the form of snack products, because of its poor storability. Packaging and storage studies were conducted on snack products prepared from bajra in combination with wheat and pulses. The products were stored in five different types of containers viz., glass, tin, plastic (PET) and polyethylene bags of 200 and 400 gauge. Organoleptic properties were analysed by sensory evaluation. Proteins, carbohydrates and free fatty acid contents were determined weekly by standard methods. Glass containers gave best results in comparison to other packaging materials. Considering the criteria of economy and functionality, polyethylene bags of 400 gauge were proved to be the best. However, no significant changes were found in the chemical attributes.

GST-18 EFFECT OF TWO JUVENILE HORMONE ANALOGUES ON THE ADULTS OF *CORCYRA CEPHALONICA* STAINTON

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Topical application of different doses of juvenile hormone analogues, $RO_{20\text{-}3600}$ (6,7 epoxy-3,7 dimethyl, 1-1,3,4 (methylenedioxy-phenoxy-2-nonene) and FME (farnesyl methyl ether) was made on freshly emerged (0-6 h) unmated adults of *Corcya cephalonica* stainton. Crosses were allowed between untreated males and females, treated males and untreated females, untreated males and treated females and treated males and females. Highest degrees of reduction in fecundity. oviposition period, egg viability and sterility were obtained in the highest dose level of 7 µg/moth ($RO_{20\text{-}3600}$) and 15 µg/moth (FME), but reductions were maximum where both sexes had been treated. The sterility effect of JHA's on the reproduction of *C. cephalonica* is significant and they may be considered for use in any integrated programme for the control of this pest.

GST-19 A STUDY ON PREPARATION AND PROXIMATE COMPOSITION OF TRADITIONAL PRODUCTS PREPARED FROM BENGALGRAM

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In the present investigation, an attempt was made to study the effect of processing on flavour, acceptability and proximate composition of traditional products prepared from Bengalgram. The products selected were *Puran-poli* and *Besan-poli*, Bengalgram *flour Pokodas* and soaked Bengalgram *dhal Pokodas* and Bengalgram *flour Laddus* and soaked Bengalgram *dhal Laddus*. Recipes were standardized and given for acceptability trials. The results showed no differences between the sensory properties of these products. Chemical analysis indicated differences in proximate composition between selected recipes.

GST-20 READY-TO-EAT SNACK FOOD BY EXTRUSION COOKING

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Development of snack foods from rice and defatted groundnut flour by extrusion cooking was explored. Effect of various parameters such as particle size, moisture content, temperature of extrusion barrel, feed rate and the type of extrusion die were studied. A moisture level of 16-17 percent and barrel temperature of 150- 205°C with a feed rate of corresponding to 0.2 kg/min. was found best for the extrusion of rice-based products. Organoleptically the product was crisp, attractive and highly liked by taste panel. The role of salt, fat and spices on the extrudate characteristics and their storage stability were investigated.

GST-21 STUDIES ON PREPARATION OF DEHYDRATED SPROUTED PULSES

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Realising dietary importance of sprouted pulses, investigation was carried out for preparation of instant sprouted pulses from greengram, cowpea, moth bean and horsegram. Appropriate steeping time was 8 h for moth-bean and 12 h for remaining pulses, with 12 h sprouting time. Plain water steeping and sun drying for 10-12 h without blanching gave acceptable product. The drying ratios were 1:0.95, 1:0.92, 1:0.90 and 1:0.90 with rehydration time of 4, 2.5, 3 and 4.25 h for greengram, cowpeas, moth bean and horsegram, respectively, at ambient and 4 to 5 min for horsegram and 3 min. for other pulses in boiling water. No significant differences were observed in the quality of dehydrated sprouted pulses stored in polyethylene bag, tin-container and plastic jar. Thus, dehydrated sprouted pulses can be prepared and marketed in polyethylene bags for use as per convenience after short time rehydration.

MILLING AND BAKING TECHNOLOGY

MBT-1 A SEMI-QUANTITATIVE ANTI-MICROBIAL EFFICIENCY TEST FOR CALCIUM PROPIONATE USED IN BAKERY INDUSTRY

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Calcium propionate is a commonly used preservative in bakery industry. The PREVENTION OF FOOD ADULTERATION ACT (PFA) restricts use of propionates at 5000 ppm for bread on flour weight basis. Calcium propionate quality used in bakery industry should be as per specifications IS 6031-1971 of Bureau of Indian Standards. During the regular analysis of samples from various sources, it was observed that majority of samples, though passed the analytical specifications prescribed under IS.6031, failed to inhibit the growth of mold and rope (*Bacillus* sp.) in bread when used at the maximum prescribed levels. An anti-microbial efficiency test using a thermostable strain of *B.subtilis* NCIM 2479 spore was developed as a quality standard to test anti- microbial effectiveness of calcium propionate. The possible reasons for the lack of calcium propionate efficacy in such samples could be due to the presence of impurities (calcium salts of other fatty acids). This method has proved to be efficient and can form a routine quantity control programme which could be adopted in food industries wherever calcium propionate is used as a preserative. We also recommend that such quality evaluation be introduced by Bureau of Indian Standards.

MBT-2 WHEAT BREEDING AT PUNJAB AGRICULTURAL UNIVERSITY TO SUIT THE FARMERS AND PROCESSORS

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Wheat Breeding lines of Punjab Agricultural University at different stages of development are tested comprehensively for their suitability for different industrial sectors. Presently SDSS test, polyacrylamide and inframatic tests are being extensively used to identify breeding materials and cultivars suitable for breads, *chapatis, pastas* biscuits and cakes. Out of 19 varieties recommended for cultivation in the State, the recent studies identified the cultivars: PBW 34, PDW 215, DWL 5023, PBW 175 and PBW 154 to be of hard texture. The varieties HD 2329, PBW 120, PBW 226, SKAML 1, PBW 2265 and PBW 2285 were found medium hard with rest of the varieties showing medium soft texture. The varieties PBW 34 and PBW 215 along with lines Tressor, Vespro, Murgia were found best suited for *pasta* products. The varieties SKA, TL 1210 and TL 419 were identified to be best suited for biscuits. The cultivars WL 1562, SKAML 1, PBW 175, PBW 2265 and PBW 2285 were found suitable for breads and *chapatis*. Significant differences for protein contents, sedimentation values and loaf volume were observed in samples of HD 2329 and PBW 34 collected from mandis of different districts of Punjab. The samples of HD 2329 from Giderwindi, Bhawanigarh,

Malerkotla, Lahrabinga, Zira, Ajitgarh, Aur and Ropar with above 13.0 percent protein, 50 cc sedimentation value and 560 cc loaf volume were identified to be suitable for breads. Collection, milling and bagging of flour for breads from such select markets could benefit the industry.

MBT-3 DEVELOPMENT OF PROTEIN-RICH BISCUITS BASED ON WHOLE EGG POWDER

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Biscuit is a snack food popular among both the Armed Forces and the Civilian population. Commercial biscuits are deficient in proteins. Incorporation of egg powder in comparison to other protein-rich materials, will increase the nutritive value and in turn help improve the nutrition of soldiers, sailors and also civilians. A method was standardised for the preparation of protein-rich biscuit containing commercially available spray dried egg powder. Flavours like vanillin, vanillin plus pineapple and vanillin-orange were used to mask the egg flavour. They were packed in paper-aluminium foil-polyethylene, BOPP and metallised polyester and were evaluated for their shelf-life at different temperatures. The biscuits containing these combination of flavours were found to be acceptable for a period of 6 months at ambient temperature and at 37°C. Data will be presented on the physico-chemical and organoleptic changes of these biscuits packed in different packaging materials during storage.

MBT-4 MILLING HUMIDIFIED RICE - A NEW APPROACH FOR ENERGY SAVING

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More than 50 percent energy consumed in rice milling is in debranning operation. A new approach of debranning after raising the moisture of brown rice by humidification at laboratory scale was explored to reduce the energy consumption. Raw brown rice (cultivar Sona) was debranned in a laboratory McGill Miller which required 180 sec. to attain 6.4 percent degree of polish. The milled rice had a whiteness value (WV) of 13.7 percent and the energy consumed during operation was 171 Wh/kg. Upon raising the moisture content of brown rice from 11.5 to 15 percent (as is basis) in a humidity chamber, the rice required 75 sec. to attain 5.0 percent polish and the same level of WV. The net energy consumed was 138 Wh//kg i.e., 20.8 percent less than untreated control. Breakages were 23 and 27.5 percent, respectively.

Parboiled rice (cultivar Madhu) had WV, degree of polish and milling time of 7, 5.1 percent and 270 sec. when milled at 11 percent moisture content; 7.1, 3.3, 150 sec. at 15 percent moisture and 7, 5.6 and 390 sec. at 17.5 percent moisture, respectively. Breakage was negligible. Milling of

parboiled rice at 15 percent moisture reduced the energy consumption by about 45 percent, as compared to lower moisture. Milling of parboiled rice, in general, consumed more energy than raw.

MBT-5 MOISTURE SORPTION BEHAVIOUR OF SOME TRADITIONAL FLOUR BASED SWEETS

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Indian sweetmeat industry is on the threshold of revolution. The focus is shifting from household preparation to sale across the counter, which necessitates the need for packaging. Selection of proper packaging material requires careful assessment of product characteristics, storage environment, expected shelf-life and cost. The present investigation reports the moisture sorption characteristics of selected traditional flour based sweets. Products selected for study included *Mysorepak*, *Sohanpapdi*, *Rawa besan* and *burfi*, *Rawa mungdal burfi* and *Bundi laddoo*. The moisture, fat, and sugar contents of products ranged between 2-16, 18-42 and 25-52 percent, respectively. Moisture Sorption Isotherm indicated that Equilibrium Moisture Content at 60-70 percent RH was critical for the products. Products with higher fat content equilibrated to lower moisture content and *vice versa*. The observations indicated the suitability of polypropylene and high density polyethylene for packaging.

MBT-6 INFLUENCE OF FLOUR FROM BRAN FINISHER AND FILTER STOCK ON THE QUALITY OF BAKERY PRODUCTS

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Flour milling industry in India is currently producing two types of first and second quality flours for the use of baking industry. Generally, the second quality flour contains the flour obtained from bran finisher (BF) and filter stock (FS). The effect of these flours on the quality of bakery products was studied. The ash content of flour increased by 0.02 and 0.04 percent with 10 percent addition of BF and FS flours, respectively. The SDS sedimentation value decreased by 11 ml, when FS flour was added. The gluten content decreased by 1.4 and 1.8 percent with incorporation of BF and FS flours, respectively. The water absorption increased by 2.6 and 3.6 percent, while the stability decreased by 1.5 and 1.5 min, with the addition of BF and FS flours, respectively. Also, the dough strength decreased as shown by reduction in extensograph area values. The specific volume of bread decreased by 0.20 and 0.35 ml/g and crumb firmness increased by 2.1 and 6.32 N on addition of BF and FS flours. The FS flour had a significant adverse effect, while BF flour had negligible influence on the quality of biscuits and cookies.

MBT-7 STORAGE STUDIES ON RAW AND STABILISED WHEAT GERM

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Wheat germ, a complete nutrition capsule and a by-product of flour milling industry, is almost wholly disposed off as animal feed due to its poor storage stability. The present study was aimed at stabilizing the wheat germ and assessing its storage stability for a period of one year. Wheat germ was stabilised by six different treatments, viz., i) air-oven ii) infrared oven iii) autoclaving iv) microwave v) defatting and iv) addition of antioxidant. The raw and stabilized wheat germ, packed in polypropylene (200 gauge) packets, were stored at ambient conditions for a period of one year. The quality of stored samples was assessed in terms of moisture, fat content, FFA, PV and residual lipase activity at regular intervals. The results indicated that, stabilization of wheat germ improved its keeping quality. Raw samples were found to be heavily infested after 45 days of storage, whereas none of the treated samples showed infestation upto one year. Amongst the different stablized samples, autoclaved samples showed best keeping quality characteristics.

MBT-8 EFFECT OF MILLING METHODS OF WHEAT ON THE QUALITY OF DOUGH AND *TANDOORI ROTI*

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Effect of processing wheat into whole wheat flour in hammer, pin, roller and stone (plate) mills on the quality of dough and that of *tandoori roti* was investigated. Considerable variation in particle size distribution was observed. Overtailings of 10 XX sieve ranged from 15.9 to 26.4 percent. Among the various chemical characteristics studied, the damaged starch and diastatic activity ranged widely from 12.14 to 18.06 percent and from 223.7 to 306.7 mg of maltose/10 gm of flours respectively. Water absorption capacity also varied. Stone milled flour showed the highest (76.2 percent) water absorption, while the roller milled flour had the lowest (66.2 percent). The variations in values may be attributed to the severity of grinding in different mills. The *tandoori roti* prepared from stone milled flour had desirable softer texture, light brown coloured spots, sweetish taste and gave low shear value in Instron texturometer. The *rotis* made from roller milled flour had poor quality characteristics. The studies clearly indicated that, the wheat ground in stone mill (plate mill) was best suited for the preparation of *tandoori roti*.

MBT-9 EFFECT OF ADDITIVES ON THE VISCOAMYLOGRAPH CHARACTERISTICS OF THE COMPOSITE FLOUR BLENDS FROM WHEAT, SORGHUM, FINGER MILLET AND PEARL MILLET

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In order to study the pasting properties of flours from pearl millet, finger millet, and sorghum incorporated at 85 percent level, each with wheat flour, viscoamylograph characteristics were determined with and without additives such as GMS, SSL and CMC. The temperatures of initial rise in viscosity of 14.4 percent flour slurry were 61.5°C, 67.5°C, 69°C and 69°C, respectively for wheat, pearl millet, sorghum and finger millet flour. Greater differences were noticed in the indices of their viscograms. The values for peak viscosity were 960 BU, 110 BU, 750 BU, 1120 BU, those of viscosity at first hold were: 610 BU, 60 BU, 460 BU and 710 BU and for cold paste viscosity 1280 BU, 160 BU, 1390 BU and 1110 BU for wheat, pearl millet, sorghum and finger millet, respectively. These values suggest that, composite flours from sorghum and finger millet could be used in the preparation of *pasta* products like vermicelli. Inclusion of GMS as additive at 0.25 to 0.5 percent level in combination with CMC at 1.0 to 1.5 percent increased the values of viscosity indices considerably, except for the pearl millet which remained almost unchanged.

MBT-10 STUDIES ON TRADITIONAL SWEETS - *CHIROTI*

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Chiroti is a popular sweet in Southern India. Basically, it is fine wheat semolina dough, flattened using a rolling pin repeatedly layered with fat, re-rolled into circular discs and deep-fat-fried. The product is multilayered, crisp and flaky- like puffs. It is served and consumed with powdered sugar and milk. Flakiness and more layers in the product are the desired indices of *chiroti*. Known recipes were adopted and the effect of semolina, gluten content and quality, type and content of fat used, use of additives and deep-fat-frying on the quality of *chiroti* were studied.

Medium soft wheat with 9-10 percent protein content was better suited. *Chiroti* using semolina with higher protein content gave a sticky dough, and the final product was hard. Semolina based *chiroti* was crisper without continuous layers, while refined wheat flour based *chiroti* was not so crisp, in spite of having thin continuous layers. A blend of semolina and maida yielded a crisp product with distinguished continuous layers piled one above the other. Among the fats used for layering, margarine gave the desired results. Phospholipids at 0.5 percent level in the dough improved the product with respect to fineness of the grain texture in the layers, lowered the amount of fat and increased the volume of bulging of the product during frying.

Optimum conditions were arrived at for working of the dough based on farinograph and extensograph studies. Texture parameters like firmness and stickiness of the dough and crispness of the product were studied using Instron testing machine.

MBT-11 SUITABILITY OF FULL-FAT AND DEFATTED RICE BRAN OBTAINED FROM INDIAN RICE FOR USE IN FOOD PRODUCTS

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The effect of blending of different types of rice bran in wheat flour on the rheological, pasting and baking properties was reported. Dough development time and strength as measured through farinograph decreased with the blending of unstabilized full-fat and defatted bran, whereas blending of stabilized full- fat and defatted bran improved the dough strength. Pasting properties revealed an increase in gelatinization temperature and decrease in paste viscosities and set back values with the blending of various types of rice bran. Bread volume and cookie spread decreased with blending of different types of rice bran. However, the decrease was more pronounced with the defatted bran. Muffin volume improved with the blending of rice bran. Stabilized full-fat bran upto 20 percent level and unstabilized full-fat or stabilized defatted rice bran upto 10 percent was found suitable in various food products.

MBT-12 ENERGY REQUIREMENT, AUDIT AND CONSERVATION IN ROLLER FLOUR MILLING INDUSTRY

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Current wheat production in India is 57 million tonnes. About 82 percent of this is being processed in chakki mills, which consume about 2808 x 10^6 units of electrical energy. To cater to the wheat-based industries, another 13 percent (7.5 million tonnes) of wheat is being processed in 700 organised roller flour mills (RFM), which consume about 465 x 10^6 units of electrical energy. The total expenditure on wheat processing thus costs about 5000 million rupees. The International School of Milling Technology (ISMT) studied electrical power distribution and utilisation from wheat input to product output using a training mill (mill A, capacity 20 tonnes per day, TPD) and other three commercial mills (B, C, D; capacity of 60, 100 and 125 TPD, respectively).

The transformer ratings of these mills were 12.50, 5.25, 7.50 and 6.50 KVA, while induction motor loads were 11.40, 5.82, 5.58 and 5.19 HP, respectively, against standard of 4.80 HP per tonne of wheat processing. Pre-grinding sections of A, B, C and D mills had 27.41, 29.80, 24.19 and 22.19 percent of total load, while mills A, C and D had grinding section, break rolls to reduction roll loads of 14.24:13.16, 21.51:21.51 and 20.80:23.04 percent of total load, Mill B had partial group drive load

of 40.26 percent full load in H.P. Material conveying loads of Mills A, B, C and D were 32.45, 17.19, 15.23 and 24.26 while sifter, purifier and other redressing loads were 12.72, 12.75, 17.56 and 9.71 percent of full load, respectively. Percentage of fines recovery of mills A, B, C and D were 65.0, 59.9, 66.6 and 76.4 and energy consumption per tonne of wheat processing were 109, 67, 83 and 63 units at 0.983, 1.094, 0.989 and 1.035 grinding ratio, respectively.

It was found that Mill (D 125 TDP) had produced higher percentage of fines with least energy consumption. Mills A, B and C cost Rs. 115, Rs. 10 and Rs. 50 higher per tonne of wheat processing, due to excessive electrical load.

MBT-13 EFFECT OF INCORPORATION OF BREAD CRUMB ON THE RHEOLOGICAL AND BREAD MAKING CHARACTERISTICS

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Normally, 1 to 2 percent of bread produced on a commercial scale is wasted due to minor variation in the quality such as shape, weight , size and crust colour. In order to utilise such products, studies were carried out to determine the possibilities of using the same in breads. Incorporation of 10 percent bread crumb increased the water absorption from 61.6 to 66.2 percent, decreased stability from 8 to 5.0 min. Extensograph characteristics indicated that there was no significant difference in the values of resistance to extension, while extensibility decreased from 175 to 120 mm. The dough became stiff as indicated by increase in the ratio figure from 2.6 to 4.08. Gas retention capacity of the dough decreased as indicated by decrease in the dough raising capacity from 144.4 to 111.1 percent. Pasting characteristics indicated that gelatinization temperature increased from 61.5 to 63°C, peak viscosity decreased from 990 to 610 BU and cold paste viscosity at 50°C increased from 950 to 1025 BU with incorporation of 10 percent bread crumb. Bread making trials showed that, loaf volume and specific loaf volume decreased from 580 to 450 ml, 4.12 to 3.25 ml/g, respectively, on addition of 10 percent bread crumb. There was slight darkening of the crust colour as well as hardening of crumb texture. However, there were no significant differences in various quality parameters of bread upto 5 percent level of incorporation of bread crumb.

MBT-14 EFFECT OF INCORPORATION OF PEARL MILLET FLOUR ON THE QUALITY OF SWEET DOUGH BISCUITS AND BREAD

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Suitability of pearl millet incorporation in the preparation of bakery products such as sweet dough biscuits and composite bread was studied. Pearl millet polished to 3.7 percent level, was ground in disc mill to yield flour, 97 percent of which passed through 60 mesh sieve. Chemical and

rheological characteristics of blends having 10 to 50 percent pearl millet in the wheat flour were determined. Changes in the quality of composite biscuits and bread as affected by variations in ingredients and processing conditions were studied. The spread ratio of biscuits varied from 8.75 to 9.00 and that of breaking strength (g. force) from 2195 to 1204. The surface colour (ΔE) of biscuits varied between 44.4 and 48.3. Incorporation of pearl millet up to 30 percent was found to be optimum for obtaining comparatively good quality sweet dough biscuits. The specific loaf volume of composite bread containing 20 percent pearl millet was 3.0 ml/g which was close to the control (3.4 ml/g), with soft crumb and uniform grain texture.

MBT-15 EFFECT OF DEFATTED SOYA FLOUR ON THE QUALITY OF BUNS

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Studies were conducted for the preparation of high protein buns by pratically replacing wheat flour with defatted soya flour. Medium strong wheat flour having 11.8 percent protein, 21 ml sedimentation value, 10.4 percent dry gluten, 500 falling number, 121 percent dough raising capacity and 240 mg of maltose/10 g flour was substituted with 5, 10 and 15 percent defatted soya flour. The farinograph water absorption increased gradually from 60.4 to 67.2 percent as the soya content increased from 0 to 15 percent in the blend. The dough development time increased from 2.0 to 5.5 min indicating increasing mixing requirements. The stability of the dough was unaffected. The mixograph characteristics showed gradual reduction in dough strength from 75.9 to 71.0 cm^2 as the soya content increased. With increased addition of soya flour, the extensograph extensibility decreased and resistance to extension and area values decreased gradually indicating adverse effect on the dough properties. Though the specific volume of buns decreased with increased addition of soya, the firmness of crumb decreased, indicating improvement in softness. The protein content of buns increased by 4.8 percent on substitution of wheat flour with 10 percent flour. Addition of SSL or soya lecithin improved the quality of buns containing soya flour. The results indicated that high protein acceptable quality buns can be prepared by replacing wheat flour with 10 percent defatted soya flour and using SSL or soya lecithin as additives.

MBT-16 STUDIES ON THE FEASIBILITY OF UTILISING PUFFED BENGALGRAM FLOUR IN BAKERY PRODUCTS

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Puffed Bengalgram flour (PBGF) was substituted at 5 to 25 percent levels in bread formula and at 10 to 40 percent levels in biscuit formula. As the level of PBGF increased, dough stability

and mixing tolerance index were found to decrease. The gelatinization temperature increased with the incorporation of PBGF. With higher levels of PBGF, the proof time and bulk density of bread increased, while the loaf volume decreased. From the organoleptic point of view, improvers were found necessary at higher levels of PBGF substitution. Potassium bromate was found to be an effective improver. PBGF substituted bread could be stored upto 4 days when packed in polyethylene bags. Biscuits substituted with PBGF upto 20 percent level could be stored well in polypropylene pouches kept in air-tight containers at ambient conditions. There was an increase in the protein and lysine contents of bread and biscuits. ERH studies showed that PBGF substituted biscuits equilibrated upto 40 percent RH were quite acceptable. The maximum tolerable moisture absorption by biscuits revealed that high density polyethylene (density 0.954) could be used upto 20 percent PBGF substitution.

MBT-17 EFFECT OF INCORPORATION OF REFINED SORGHUM FLOUR ON THE RHEOLOGICAL AND BAKING CHARACTERISTICS OF WHEAT FLOUR

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Commercial wheat flour having 0.54 percent ash, 9.63 percent protein, 8.96 percent gluten, 23 ml sedimentation value, 13.4 percent damaged starch and 198 mg maltose/10g flour diastatic activity representing typical Indian medium strong wheat flour quality characteristics was substituted with 5, 10, 15 and 20 percent refined sorghum flour having 75 and 85 percent extraction rates. The farinograph water absorption decreased by 1.5 and 4.4 percent when wheat flour was substituted by 20 percent sorghum flour having 75 and 85 percent extraction rates, respectively. Both farinographs, valorimeter and extensograph area values showed reduction in dough strength with increased sorghum content in the blend. The 85 percent extraction rate sorghum flour indicated more adverse effect on dough properties than 75 percent extraction rate flour. The loaf volume decreased and the crumb firmness increased with increase in sorghum flour content. With optimised ingredients and processing conditions breads comparable in quality to that from wheat flour were prepared with wheat and sorghum flour blends for the utilisation of sorghum in bakery product.

MBT-18 EFFECT OF GAMMA IRRADIATION ON THE RHEOLOGICAL PROPERTIES OF WHEAT

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The studies were conducted to evaluate the rheological properties of flours, as influenced by irradiation (0-125 Krad) and variety (WG-357 and PV-18) using mixograph, amylograph and fairinograph. There was no significant effect of irradiation on the mixograph and fairnograph properties as compared to control. The varietal differences in dough development time and water

absorption were distinct, i.e., WG-357 showed higher values as compared to PV-18. The most spectacular effect of irradiation was on the amylograph peak viscosities of the flours. Peak viscosity decreased with increase in level of irradiation. Peak viscosity of WG-357 was higher (700 B.U.) as compared to PV-18 (580 B.U). The flours of WG-357 showed slight increase in peak viscosity of 25 Krad, while it decreased for PV-18. At 75 and 125 Krad dose levels, respectively, the viscosities decreased perceptibly in both the varieties. The peak viscosity decreased by 37.5 percent in case of WG-357, while it was 45.2 percent in case of 125 Krad samples. The moisture level i.e., 9 and 13 percent at which the wheats were irradiated had no significant effect on the peak viscosities of the flours.

MBT-19 SIMULATION TECHNIQUE IN PRODUCT DEVELOPMENT - A CASE STUDY FOR HIGH PROTEIN COOKIES

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Modelling the phenomena involved in Food Processing is a recent trend. This communication describes the use of second order, multivariable polynomial model for optimal development of high protein cookies containing legume flour. The model was based on experimental data, with proportion of various ingredients as controllable causes, and some physical and organoleptic properties of cookies as the effects. Simultaneous models correlating the protein content and cost of the product to the proportion of ingredients were developed independently.

The model showed excellent complience with respect to few properties such as spread factor (SF), density and Technological Quality (TQ) which were the overall score on hedonic scale. The complience was not satisfactory with respect to rank and cracking strenghth. Further, optimisation was carried out with Techno- economic quality (Teq) as objective function. When desirable combination of product properties were not possible at such optimal set of ingredients, the objective function was redefined as TEQ * J, where J was nearness to desired properties.

OILS AND FATS

OFT-1 DIRECTED INTERESTERIFICATION - PREPARATION AND QUALITY ASSESSMENT OF VANASPATI LIKE FATS

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Experiments have been conducted to produce vanaspati like fat using interesterification process and evaluate its quality parameters in comparison with vanaspati (hydrogenated fat). The directed interesterification was carried out for genuine groundnut oil, cottonseed oil, palmolein and mixtures of groundnut oil with palmolein, cottonseed oil with palmolein in the ratio of 70:30 and 50:50. The neutralised, washed and dried oil and their mixtures were heated at 90°C under vacuum and 0.2 percent of sodium methoxide catalyst was used to achieve randomisation. The directed interesterified fats were tested for melting/slip point, congeal point, iodine value, free fatty acid percent and moisture percent. The directed interesterified fats were found to be very close to the vanaspathi with regard to the above characteristics, except that they were found to be less firm, but with more polyunsaturated fatty acids than vanaspati obtained by conventional hydrogenation process.

OFT-2 FATTY ACIDS FREE VANASPATI LIKE FAT BY INTERESTERIFICATION

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Hydrogenated fat (vanaspati) contains 45-50 percent or more trans fatty acids. These artifacts formed during the catalytic hydrogenation of vegetable oils and have specific advantages of increasing the solid content of fats. However, trans fatty acids are implicated in cardiovascular diseases. Alternative to hydrogenation is interesterification process, which involves ester - ester interchange. In this process, the artifacts are not formed. Semi-purified red palm - sunflower (8:2) blends were interesterified using sodium methoxide catalyst. The products had natural yellow colour due to the presence of beta-carotene. The interesterified fat had melting point of 30°C and solid fat index of 21.3 percent at 25°C.

OFT-3 CHARACTERISATION OF SUNFLOWER (*HELIANTHUS ANNUUS*) SEED WAXES

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Wax from sunflower seed hull was isolated and characterised. The seed hull contained 2.1 percent wax. The isolation of wax was achieved by extraction with chloroform (1:6) and precipitation with chilled acetone. Further purification was done by prepartive thin layer chromatography on silica gel-G using benzene:chloroform (7:3) as developing solvent followed by elution with chloroform-methanol (2:1) and dried under nitrogen stream. The composition of the purified wax after saponification and esterification was carried out by gas-chromatography on Dexil-300 and DEGS columns for alcohol and fatty acids. The waxes contained arachidic, behenic, lignoceric and cerotic acids as major fatty acids constituting 10.9 percent, 10.7 percent, 12.8 percent and 8.7 percent, respectively. Triacontanol, a plant growth regulator has been detected in the wax.

OFT-4 PACKING, HANDLING AND STORAGE OF LIPOXYGENASE FREE FULL FAT SOYFLOUR

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Lipoxygenase-free full fat soyflour was prepared by hot water blanching and hot air oven heat treatment to raw soybean. Whole soybeans, splits and flours of raw and treated soybeans were used to evaluate their packaging and handling characteristics in polythene bags upto 400 μm thickness. Storage quality of differently processed soyflours was judged in polythene bags of 100 um and 50 μm film thickness. Polythene bags of 50 μm film thickness was judged suitable by stack load test for packaging of whole soybean, soysplits and soyflours. For safe handling, however, the minimum film thickness of 200 μm was found to be safe as decided by the drop test. 100 μm film thickness of polythene bags was considered (288-313 K; 40-92 percent RH) on account of free fatty acids (FFA) rise and change in moisture content. The lipoxygenase free ful-fat soyflour produced by dry heat was found to have relatively better storage quality over raw and blanched soyflour. Overall, the polythene bag film thickness of 200 μm was considered for safe packaging, handling and storage of full-fat soyflour upto 45 days under ambient conditions.

OFT-5 UTILIZATION OF GHEE RESIDUE IN COOKIE-MAKING

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A study was undertaken to explore the possibility of utilization of ghee residue in cookie making. Increasing levels (10 to 30 percent) of ghee residue were incorporated during the initial stages of mixing the ingredients. Incorporation of ghee residue increased yield and spread ratio (diameter to thickness) of cookies. It also improved colour, texture and taste of cookies. Effect of additives, e.g. glyceryl monostearate (GMS) and sodium stearoyl lactylate (SSL) was also studied. GMS and SSL further improved spread ratio and appearance/top grain but did not appreciably affect the colour, texture and taste of cookies containing ghee residue.

OFT-6 EFFECT OF GAMMA-IRRADIATION ON THE LIPID COMPOSITION OF WHEAT

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The studies were conducted to investigate the effect of gamma- irradiation from CO^{60} in dose levels of 0, 25, 75 and 125 Krad on the lipid composition of wheat varieties of 357 and PV-18. The wheats were adjusted to 9 and 13 percent moisture before irradiation. The extracted lipids of irradiated and control wheat samples were investigated using GLC, infrared spectroscopy for free fatty acids and extent of oxidative changes. The fatty acid composition of lipids showed no significant change. The infrared spectra of both the varieties were superimposable and the lipids of irradiated wheats did not differ from their controls. Some peculiar features of indigenous wheat lipids were observed mainly in OH stretching and C-H stretching. The stretching of P-O-C accompanied by two bands pertaining to N-H deformation and peculiar to Indian wheats, has not been reported previously. The presence of these and stretching can be attributed to greater number of hydrogen bonds or stronger overall polarity of Indian wheat lipids. The variety and irradiation dose had no influence and FFA values were non- significant.

OFT-7 NICKEL CONTENTS IN VANASPATI AND CHOCOLATES

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Nickel (Ni) in fine dispersed form is used as a catalyst by the hydrogenation industry in the manufacture of vanaspati, margarine and bakery shortening. Though catalyst is removed after hydrogenation by filtration, retention of some of the metal catalyst in the hydrogenated vegetable oil

cannot be ruled out and recently doubts have been raised about the occurrence of Ni in vanaspati as well as in chocolate, where vanaspati (HVO) is used as a hardening agent which helps to keep the chocolates from melting in the summer months. At present, there are no prescribed limits of Ni content in vanaspati and therefore attempts were made to determine the level of Ni as well as iron (Fe) and copper (Cu) in popular brands of vanaspati and chocolates marketed in India. The levels of Ni in 12 brands of vanaspati varied between 1.6 and 5.8 ppm with a mean of 3.53 ppm. Levels of Fe and Cu ranged between 0.75 and 8.20 and 0.015 and 0.025 ppm, respectively. Nickel contents in most of the popular brands of chocolates were found to vary between 1.15 and 2.1 ppm with a mean of 1.53 ppm.

OFT-8 STUDIES ON PHYSICO-CHEMICAL CHARACTERISTICS OF CARBON DIOXIDE EXTRACTED RICE BRAN OIL

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Extraction of rice bran with supercritical carbon dioxide at pressures of 160, 200, 240 bar and temperature of 40°C yielded rice bran oil of better quality compared to those obtained from conventional solvent extraction. The physico-chemical characteristics of carbon dioxide extracted rice bran oil and hexane extracted oil were compared. The carbon dioxide extracted oil was found to be light yellow in colour, while the solvent extracted oil was of dark reddish colour. Carbon dioxide extracted oil contained 0.4 percent of wax, 0.08 ppm of iron, 0.362 percent of phosphorus, while that of hexane extracted oil contained 2.4 percent, 0.09 ppm and 1.07 percent, respectively. The free fatty acid values were less in case of carbon dioxide extraction. The free fatty acids were found to be extracted in the initial fractions during carbon dioxide extraction. There was not much difference in saponification value, iodine number and free fatty acid composition. The carbon dioxide extracted oils contained less of phosphorus, iron and waxes.

OFT-9 KINETICS OF DEEP-FAT-FRYING OF SAMOSA

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Kinetics of deep-fat-frying in *samosa* was studied. Besides heat and mass transfer, density and textural changes occurring in the casing during frying with respect to the compressibility of the product under certain stress was studied using Instron Texture measuring instrument. Temperature profiles were recorded at the geometrical centre and also in and around the casing material. The studies indicated very little mass transfer from and into the filling material. The product was considered as a two-phase non-homogeneous system with a filling in the centre and the casing in

the periphery and was treated as a sphere for all mathematical calculations. Fick's law of diffusion was applied, moisture loss and time of frying could be correlated and diffusivity in the casing could be calculated. Similarly oil content and texture were correlated. An empirical equation relating these parameters has been suggested.

OFT-10 EFFECT OF MICROWAVE TREATMENT OF GROUNDNUT (*ARACHIS HYPOGEA*) ON THE EXTRACTABILITY AS WELL AS QUALITY OF OIL

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Groundnut was microwave treated for 30, 60, 120, 180, 240, 300 and 360 sec. The microwave treatment (MWT) of groundnuts for a short period of 30 sec. increased the oil recovery from 27.4 to 30.0 percent, while the same decreased to 23.3 percent when subjected to MWT for a longer period of time (360 sec.). In general, oil recovered from microwave treated samples showed higher free fatty acid (FFA) content and peroxide value (PV), when compared to oil recovered from untreated sample. The storage of oil at 27°C for 70 days showed increase in FFA in microwave treated samples for periods up to 120 sec., whereas, the PV increased on longer periods of MWT. The oil extracted from microwave treated groundnuts for more than 180 sec. had an undesirable dark colour. The protein extractability decreased from 8.4 percent in untreated samples to 4.5 percent for 360 sec. microwave treated groundnuts. Gradual decreases in the activities of the enzymes, lipoxygenase and lipase were observed with increased MWT period and the inactivation was 45 and 78 percent, respectively for 360 sec. microwave treated groundnuts.

OFT-11 BUTTER SPREAD WITH ENHANCED POLYUNSATURATED FATTY ACIDS (PUFA)

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International dairy federation in the year 1974 strongly advocated the necessity to enhance the level of PUFA in milk fat either manipulating the diet of milch animals or formulating a product in which milk fat is partially or totally replaced by appropriate amount of vegetable fats to circumvent the problem of plasma cholesterol levels in coronary heart disease victims. In the light of this, an attempt has been made in the present investigation to incorporate safflower oil which contains 60-70 percent unsaturated fatty acids, in butter. It was observed that, the safflower oil could be incorporated up to 30 percent in butter without any perceptible changes in sensory characteristics viz., flavour, body and texture and appearance. The incorporation of oil not only enhanced the PUFA content in experimental butter, but also improved the spreadability and softening of the butter at 5°C. The

incorporated butter remained acceptable up to 40 days without undergoing any remarkable change in physico-chemical properties.

OFT-12 FATTY ACID PROFILE OF COW AND BUFFALO GHEE

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The physico-chemical properties and nutritional properties of milk fat are influenced by the component fatty acids and the relative proportion of each fatty acid. It has been observed that there is a significant difference in the texture and oxidative stability of cow and buffalo ghee. The differential fatty acid make-up of milk fat plays an important role in the crystallisation and oxidative stability and also contributes to the difference in the rheological characteristics of a product made from milk fat. This investigation was aimed at studying the composition and fatty acid make up of cow and buffalo ghee employing GLC. The average proportions of saturated fatty acids and unsaturated fatty acids were found to be 66.27 and 33.73 percent, respectively, for cow ghee and 76.99 and 23.00 percent, respectively, for buffalo ghee. Among the saturated fatty acids, the proportion of short chain (C4-C8), medium chain (C10-C14) and long chain (C16-C18) fatty acids were found to be 8.19, 19.49 and 47.85 percent, respectively, for buffalo ghee. With regard to unsaturated fatty acids, buffalo ghee contained markedly low levels of total unsaturated fatty acids compared to those of cow ghee. However, there was no difference in the level of C18 : 3 in both the types of ghee.

OFT-13 STUDY ON THE EFFECT OF INTERACTION OF TYPE OF CONTAINER AND STORAGE PERIOD ON THE QUALITY OF SOME EDIBLE OILS

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Fresh edible oil of niger, linseed and groundnut, extracted by indigenous expeller (*Ghani*) was stored in glass, plastic, tin, iron and aluminium containers for 120 days. The storage quality was measured in terms of peroxide and iodine values. The peroxide value was found to be higher in oils stored in metallic containers as compared to glass and plastic containers. The peroxide value increased with the storage period of oil. The glass and plastic containers were found to be superior for storing the various edible oils.

OFT-14 LIPID COMPOSITION OF NEEM SEED (*AZADIRACHTA INDICA*), ESTIMATION OF BITTER PRINCIPLES AND QUALITY CHARACTERISTICS OF DEBITTERED NEEM SEED OIL

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Neem seed holds immense potential for commercial exploitation with an estimated availability of about 5 lakh tonnes annually. Neem seed kernels yield 40-45 percent greenish yellow to dark brown oil with a disagreeable odour and bitter taste due to the presence of triterpenes and sulphur compounds as lipid associates. Total lipids of neem seed coprise 93.6 percent neutral-, 6.1 percent glyco- and 0.3 percent phospho-lipids. A two stage extraction method for upgrading both oil and the meal was worked out. The total lipids and debittered oil showed similar fatty acid composition with palmitic, stearic, oleic and linoleic acids of 17.0, 17.8, 39.7 and 22.8 percent, respectively. The high content of stearic acid (16-20 percent) is usual to vegetable oils. Methods for the estimation of total bitter principles and azadirachtin content in neem seed extract were standardised.

OFT-15 FLAVOR FORTIFICATION AND CHARACTERIZATION OF RAW PEANUT OILS SUBJECTED TO ROASTING WITH PARTIALLY DEFATTED PEANUT MEAL UNDER VARIOUS ATMOSPHERIC CONDITIONS

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Raw peanut oil was combined with partially defatted peanut meal at a ratio of 10:1 (w/w) and roasted at 160°C for 30 min in a closed chamber under various atmospheric conditions. The addition of 10-20 percent moisture to peanut meal was essential for the formation of peanutty flavour in oil. A unique and pleasant roasted peanut flavour was achieved when roasting was carried out under atmospheres of carbon dioxide and helium. The free fatty acid content increased in the oil when the atmosphere during roasting consisted of oxygen, while slight decreases were observed in oils prepared using other atmospheric gas systems. After storage at 62°C for 35 days, free fatty acid and conjugated diene hydroperoxide contents increased in oils subjected to all treatments. However, the fatty acid composition in oil varied only within a limited range. Significant antioxidative activities were observed in peanut oils roasted with partially defatted peanut meal under carbon dioxide, helium and nitrogen.

OFT-16 QUALITY EVALUATION OF POTATO CHIPS MARKETED IN COMMERCIAL SECTOR

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Large quantities of deep fat fried products such as *boondi, khara sev*, potato chips, etc., are being processed in our country largely by the unorganised sector and widely marketed all over the country. Despite potato chips being highly popular, there have been no studies on the quality status of commercially available products. The aim of this study therefore, was to investigate variations in quality of deep fat fried potato chips in terms of moisture content and fat content of samples and peroxide value (PV), free fatty acid (FFA), thiobarbituric acid value (TBA), iodine value and refractive index of extracted fat marketed in the country. Twenty samples of potato chips marketed in India were procured and analysed. Marginal variations were observed in moisture (2.6-3.5 percent), fat (39-49) and TBA value (0.12-0.21), whereas large variations were observed in PV (1.6- 21.42), FFA (0.31-1.18 percent), iodine value (58-102) and refractive index (1.4645-1.4799).

OFT-17 EXTRACTION OF SOYABEAN LECITHIN USING SUPERCRITICAL CARBON DIOXIDE

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Phospholipids are widely used as food emulsifiers. Purified phosphatidyl choline (PC>97 percent) is used in liposomal preparations. Liposomes are considered as the best vehicles for drug delivery. Supercritical carbon dioxide extraction was employed for the removal of glycolipids, neutral lipids and other components from crude soyalecithin by subjecting the same to extraction at pressure of 200, 240 and 280 bar and at a temperature of 40°C. The crude soyalecithin contained 35 percent neutral lipids, 11.45 percent glycolipids, and 52 percent phospholipids, while that of carbon dioxide extracted lecithin contained 3.5 percent each of neutral- and glyco-lipids and 95 percent phospholipids. The phospholipid composition in crude soya lecithin was 12.33 percent Phosphotidyl Inositol (PI), 0.52 percent Phosphatidyl serine (PS), 18.31 percent Phosphatidyl Ethanolamine (PE), 21.33 percent Phsophatidyl choline (PC), while the carbon dioxide extracted soyalecithin contained 14.38 percent PI, 31.11 percent PE, 47.49 percent PC. The fatty acid composition for the crude soya lecithin and carbon dioxide extracted soya lecithin were C16, 15.82 and 21.94; C18, traces; C18:1, 19.78 and 16.7; C18:2, 52.19 and 54.96; C18:3, 6.22 and 5.34, respectively. There was an enrichment of phopholipid components (upto 90 percent), but no significant difference in fatty acid composition.

MISCELLANEOUS

MIS-1 EVOLVING A NEW MODEL FOR EDUCATION AND TRAINING IN FOOD SCIENCE

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The necessity for evolving a new model for education and training in food science arises mainly from the unprecedented growth in knowledge and technologies applied in food and beverage industry and from the increasing number of medium and small scale food industries. It is rather important, to adopt a systematic approach in continuing eduction to accelerate the transfer of technology and knowledge between industry and academia. In order to meet the challenges of expanding horizons of knowledge and technologies applied in food industry, the industries should have a more flexible model, wherein they can choose the level and extent of knowledge and training to be imparted to their working personnel. Such a model also should help in establishing an effective and sustained link between research institutes, universities and industries for keeping pace with the advancements in Food Science. The increasing demand for more personnel with medium-to-higher level skills rather than lower level workers and the increasing range of technologies applied in Food Science necessitates a model where a general as well as specific approach to the subject is possible. The preliminary studies on some medium level brewery industries showed that most of these industries rely on the on-job training, rather than specialised training. This emphasises the need for a model, where the new techniques or developments in basic knowledge can be imparted at the work spot itself. The open learning system which is a recent development in education would facilitate achievement of the above objectives in the possibility of a model incorporating all the above features.

MIS-2 SNACK FOODS - AN INCOME EARNING OPPORTUNITY IN BANGLADESH

MIKE BATTCOCK

Intermediate Technology Development Group
Dhaka-1209, Bangladesh

This poster examines the various snackfoods in Bangladesh. It deals with the benefit derived from the snackfoods by the Groups who are at a disadvantage. The snackfoods industry provide employment to many, besides giving hygienic and low cost food for the poor. The paper also discusses about suggestions for the organisation meant to assist the poor to establish viable street food business.

MIS-3

INFORMATION FOR SMALL-SCALE FOOD PROCESSING

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Traditional food products are being replaced by mass produced products. Not only is this concentrating the means of production into the hands of a few, but also this vast store of traditional technologies is being lost. Intermediate Technology (IT) is documenting the production of traditional foods that are commonly sold by small-scale producers. This will enable developmental workers and entrepreneurs to improve the quality of existing products and have sufficient information to develop foods that are new to their areas. Material has already been collected from India, Sri Lanka, Bangladesh, Peru, Guatemala and West Africa. Examples of the information and the form in which it is documented are illustrated. Intermediate Technology has also collected information about small-scale food processing equipments. Through a variety of means from publications to training courses, IT is transferring this information to the people that can most benefit from it. This work will raise the profile of traditional technologies and influence policy makers to recognise the amazing range of skills and expertise already existing and the positive benefits that these technologies can bring.

ADDENDUM

BTM-90 DISTRIBUTION OF LACTIC ACID BACTERIA IN MILK- AND CEREAL/PULSE-BASED FOODS

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Lactic acid bacteria (LAB) make up an integral part of the healthy human intestinal flora through their metabolic activities. They also provide therapeutic benefits by controlling the proliferation of undesirable pathogenic bacteria. In the present study, cultures of LAB were isolated from butter, curd, cheese and fermented batters. The isolates were identified by standard methods. The viable lactic counts in 16 samples tested was found to be in the range of 10^5 to 10^{11} cfu/gm. The survival of the isolates in MRS broth at various pH levels, gastric juice and bile salts was studied. Further, the antibiotic sensitivity of the isolates was carried out using standard bio-discs. The results emphasize the use of traditional Indian fermented foods for intestinal problems, nutrition and maintenance of good health.

BTM-91 IMPROVEMENT OF AMYLASE ACTIVITY IN MALTING

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The brewer's most important raw material has always been barley grain which is converted into malt by steeping, germination and kilning. Enzymes developed during germination play vital role in the evolution of quality of malt (Disastatic power, Liquefying power, Malting losses, Extract yield and Index of nitrogen modification etc.) prepared from cereal grains. The objective of present investigation was to assess the amylase activity of barley during malting, with gibberellic acid (GA) treatment. For this purpose, 4 varieties of barley K454-93, DL-102, DL-36 and Amber K-71 were taken. An increase in amylase activity by 60-70 percent was observed with the use of GA (0.8 ppm) during steeping (for 72 h at 13°C), whereas 75-90 percent increase in amylase activity was observed when GA was used during germination (for 7 days at 15°C).

BTM-92 EFFECT OF SMOKE (HOT SMOKING) ON MICROFLORA DURING PROCESSING AND PRESERVATION OF OIL SARDINE

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Salted oil sardine was hot smoked for 6 h and stored at different temperatures. Bacteria such as *Acenitobacter, Aeromonas, Bacillus, Citrobacter, E. coli, Flavobacterium, Micrococcus, Plesiomonas, Pseudomonas, Proteus, Staphylococcus* and *Vibro* sp. and fungi such as *Aspergillus, Cladosporium, Mucor, Penicillium, Rhizopus, Sporotrichum* and *Sacchoromyces* were isolated during the early stages of smoking. However, these organisms could not be isolated after high temperature smoking. Storage studies showed the presence of bacteria, but failed to grow and bring about the spoilage of product.

BTM-93 DECENTRALISED SPIRULINA MASS CULTURE FOR LOCAL USE: A FEASIBILITY STUDY

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Under the aegis of the Department of Biotechnology, Government of India, 5 families in a South Indian village, Kurunthamparai, Puddukkottai District were engaged in mass culturing *Spirulina fusiformis* (MCRC strain). Cement tanks of $10m^2$ area were provided to 5 women of the families. The nutrient medium used was the conventional Zarrouk medium at half concentration till scale-up stage. Depth was maintained at 20 cm and during rainy period it increased to over 30 cm. Agitation was carried out manually twice or thrice a day with a long handled stirrer. After the period of scaling-up (3-5 weeks), harvesting was done every 4th or 5th day (under good sunny conditions) or at longer intervals (7-10 days) during rainy season. The floating biomass was usually harvested. After each harvest, the chemicals were replaced according to the amount harvested. The yields in the different months varied within a range of 3 to 13 g/m^2/day depending on the season. The average yield over a one-year period (from August 1992 to July 1993) in the cement ponds was 6.86 g/m^2/day. Cement tanks generally do not get contaminated and being somewhat deeper, they have no overflow problem during rains. The production cost per kg of dry alga for labour and chemicals in cement tanks works out to Rs 120/- ($4) excluding the cost of spray drying. The capital cost for each woman for cement ponds amounts to Rs 3,000/- (under local conditions). A one year feeding programme carried out with 4000 pre-school children in ICDS centres using a sugared, extruded formulation with spray-dried powder had proved its nutritive value and acceptability. Preliminary experiments to make a sugared, extruded, solar dried formulation using fresh slurry from village by the women have shown it to be feasible. As this product can be made in village, it can also be used in village feeding centres.

BTM-94 GROWTH OF STORAGE FUNGI ASSOCIATED WITH RIPENING OF FRUITS

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In various parts of India, there is a practice of keeping custard apples (*Annona squamosa*) and other fruits for ripening in containers with foodgrains. The growth of different species of fungi on cereals and custard apples when the latter were kept for ripening in grain containers was studied. In case of apples, where the process of ripening was delayed, an active growth of fungal spores was observed on the fruit. This resulted in the release of water which was absorbed by the surrounding grains in the container. The appropriate water content of grains and the atmospheric humidity facilitated growth of fungal spores present in food grains. Thus, the sequential phenomena were observed which resulted in the simultaneous contamination of custard apple and food grains by the storage of fungi, often leading to mycotoxin production. The results showed that, the practice of keeping fruits for ripening in stored grains was not advisable and should be discouraged.

BTM-95 ALCOHOL PRODUCTION FROM *MAHUA* FLOWERS (*MADHUCA LATIFOLIA*) IN SOLID STATE FERMENTATION

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The effect of temperature, moisture content and glucose concentration on the production of ethanol from *Mahua* flowers (*Madhuca latifolia*) in solid state fermentation using 2 strains of *Saccharomyces cerevisiae* NCIM 3215 and 3205 were studied. Strain NCIM 3215 was found to be more efficient in terms of ethanol production. Natural fermentation of *Mahua* flowers did not yield appreciable levels of ethanol.

DRS-26 PESTICIDE RESIDUES IN MILK AND MILK PRODUCTS

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The present study was undertaken to estimate the residues of DDT in fluid-milk, condensed-milk skimmed and whole-milk powders in order to check, if their daily intake of residues through milk and milk products was within the acceptable daily intake (ADI). Samples of milk (raw and pasteurised), milk powders (skimmed and whole) and condensed milk were quantified for DDT and HCH residues by GC. Pasteurised cow's milk had higher levels of total HCH (100.6 ppb), as

compared to either pasteurised buffalo or standardised milk. Concentrations of DDT were found to exceed the maximum residue limit (MRL) of 1.25 ppm (on fat weight basis) in the case of raw buffalo milk and pasteurised standardised milk. While considering the isomers of HCH, beta-HCH levels in pasteurised buffalo milk were above the prescribed MRL of 0.02 ppm. As compared to fluid milk, milk-products had lower levels of DDT and HCH residues. Among the various isomers of HCH, the concentration of beta-HCH was the highest.

With reference to the dietary habits, a random survey of the middle and upper income households of Bombay showed the average per capita consumption of milk and milk products was 616 per day. The daily ingestion of total DDT and HCH residues through milk and milk products was computed as 47 and 55 μg per person, respectively, which was far below the ADI prescribed by FAO/WHO (480 μg for r-HCH and 1200 μg for DDT).

DRS-27 MICROSTRUCTURE OF *PANEER* AS INFLUENCED BY STORAGE CONDITIONS AND ITS CORRELATION WITH SENSORY AND RHEOLOGICAL PROPERTIES

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In recent times, quantitative and qualitative attributes of food systems have been interpreted in terms of microstructure. The present study envisages evaluation of microstructure in stored *paneer*, prepared from ultrafiltered (UF) standardized buffalo milk and its correlation with sensory and rheological parameters. The development of excessively fused protein aggregates in the form of clusters dominated over the vaculoes was observed in UF *paneer*, which had a high protein content. During storage of UF *paneer* at 35 and 45°C, there was a gradual incremental degree of fusion of protein matrix, which was correlated with the increased firmness. Extensive fusion of protein particles as well as fat globules during storage resulted in the development of compact ultrastructure leading to deterioration in body and texture. The quantitative rheological parameters viz., hardness, gumminess and chewiness as revealed by Instron showed a predictable trend of change in the microstructure.

DRS-28 KINETICS OF STORAGE RELATED BROWNING CHANGES IN *PANEER*

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The process of texturization at sterilization temperatures would bring about certain physico-chemical changes like browning. An attempt was made to study the influence of texturization process on the kinetics of browning during storage of *paneer*, prepared from ultrafiltered standardized

buffalo milk (1:2.5-fold concentration) using glucono-delta-lactone as an acidulant and nisin as a preservative. The process of texturization was carried out at 118°C and 121°C for 5 min., followed by immediate cooling. The product was stored at 35 and 45°C over a period of 60 days.

Irrespective of storage temperature, the texturization process carried out at 121°C produced heat-induced non-enzymatic changes at a faster rate, as evidenced from the reflectance value and formation of hydroxymethyl furfural (HMF). The intensity of browning was more prominent after 45 days of storage at 45°C, which was indicative of Maillard reaction. This was accompanied by an increase in HMF content. Kinetics study indicated zero and first order reaction with respect to fall in reflectance values and HMF formation during storage.

DRS-29 PREPARATION OF KEFIR MILK FROM BUFFALO MILK USING KEFIR GRAINS OF TWO SOURCES

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Kefir grains obtained from 2 sources (K-R and K-CH) were grown in sterile skim milk at 2 incubation temperatures viz., 30 and 40°C (K-30 and K-40). The grains were activated by soaking in 1 percent sodium bicarbonate, followed by washing in sterile cold water. Cultural characteristics showed the predominance of streptococci and lactobacilli in K-R and K-CH grains, respectively. Kefir milk prepared from buffalo milk using the mixed microflora devoid of yeasts from K-CH had desirable acid development, good flavour, body and texture in 16-18 h. at both the incubation temperatures. The overall taste of both the products (K-30 and K-40) was acceptable as evaluated for sensory attributes on a 9-point hedonic scale. The flavour in K-40 had a higher score as compared to K-30, while body and texture were better in K-30. The product were devoid of alcohol and carbon dioxide and there was no wheying off. The study indicated the preparation of kefir milk from buffalo milk, which had acceptable sensory attributes similar to that of *dahi*. Besides, kefir grains could be used as starter cultures to achieve products with uniform characteristics.

FCN-74 INFLUENCE OF FOOD ITEMS ON BLOOD GLUCOSE LEVEL

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The common man's experience related to diabetes in the daily usage of bitter gourd, menthya with butter milk, tulasi leaves, agel leaves etc. helps to reduce the blood glucose level is a debatable question. The effect of some quantity of different types of food items on post-prondial blood glucose levels (2.5 h after meal) keeping the quantity of other food items constant was studied in 50 patients. The dosage of hypoglycemic drug which the patient was consuming was kept constant. The results

indicated that, every food item changed the blood glucose level either upwardly or downwardly in accordance with the biochemical constitution of an individual.

FCN-75 **PHYSICO-CHEMICAL CHANGES IN CERTAIN VEGETABLE OILS DUE TO THERMAL OXIDATION**

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Three commonly used oils, viz., refined cottonseed, hydrogenated vegetable shortening, and mustard oil were evaluated at fresh state and at seven days of incremental interval. The results showed an increase in the refractive index, total soluble solids, specific gravity, viscosity and decrease in smoke point. The peroxide value and free fatty acid contents increased by 9.0 and 22.66 times in all the three oils. However, higher values were obtained in the case of mustard oil.

FCN-76 **TOXICOLOGICAL STUDIES ON THE CONSUMPTION OF CERTAIN VEGETABLE OILS AFTER VARIABLE THERMAL DEGRADATION**

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In order to evaluate the toxicological effect of thermally degraded oils having high content of peroxides and free fatty acids, the three commonly used oils, viz., refined cottonseed, hydrogenated vegetable shortening, and mustard oil, at fresh state and after 7, 21 and 42 days of frying of chips were forced through the digestive and assmilatory system of 21-day old male albino rats (Wistar). The data on reduction in heart weight indicated myocordial degeneration, loss in lung weight showed poor pulmonary fuction, loss in kidney weight meant nephrotoxicity, reduction in brain weight, and increase in weight of testis showed impairement of general body systems which may have serious consequences for the human health.

FCN-77 **ASSESSMENT OF ANTINUTRITIONAL FACTORS IN MAIZE AND SOY COMPLEMENTED FLOUR - AN *IN VIVO* STUDY**

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Different blends of maize flour with soy complemented flour resulted in an increase in the protein and crude fibre contents. Biological evaluation revealed that, rats fed on raw diet of soybean gained less weight, as compared to those fed on autoclaved soybean. Determination of PER and

FER in rats fed on maize:soy and their blends revealed that both values were lowest for raw soybean and highest for maize. During autoclaving, inhibitors like trypsin and haemagglutinins were destroyed, thus, improving food intake, digestibility, biological value and net protein utilisation in all groups. Petechial hemorrhage in the liver, intestine and kidneys was observed in rats fed on soybean diet.

FVP-83 A METHOD FOR BULK STORAGE OF MUSHROOM (*AGARICUS BISPOROUS*)

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In view of the cooking characteristics of button mushrooms, "bringing preservation" was tried as a method for bulk storage of mushroom before canning. The mushrooms were canned after 45 days of storage in brine. Analysis of 180 days stored canned product was found to retain all the important physical, chemical as well as organolpetic qualities as compared with the corresponding lot of freshly canned mushrooms. The technique being simple and cheap, can facilitate the small growers to store their surplus produce, until sufficient quantities are build-up for shifting to a cannery.

FVP-84 STUDIES ON THE EXTRACTION OF TEA LEAVES (*THEA SINESIS* L.) FOR PRODUCTION OF DECAFFEINATED TEA USING SUPERCRITICAL CARBON DIOXIDE

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Consumption of decaffeinated tea is on the increase in the health conscious Western world. Solvent/water extraction of caffeine has a deleterious effect on the quality of the beverage. Studies on decaffeination of tea was carried out at 4 different supercritical pressures and temperatures of 50 and 60°C. At constant temperature, increasing the pressure, increased the decaffeination efficiency; increasing the temperature increased the efficiency of extraction at lower pressure, but at higher pressures the efficiency of extraction did not show any pronounced increase under the experimental conditions. The decaffeinated tea contained 34 percent total soluble solids, 9 percent tannins, 6 percent thearubins (TR), 0.26 percent of theavflavins (TF) and was found to compare well with the control. The sensory characteristics such as colour, taste, aroma, briskness and overall quality were fairly good.

FVP-85 STUDIES ON ANTHOCYANINS FROM BLACK CARROTS

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Black carrots (*Daucus sativa*), as they are commonly known, are actually deep violet in colour at their natural pH of 6.5, due to the presence of natural anthocyanin pigments. An extract using 1 percent HCl in methanol was concentrated, which when analysed by paper chromatography (Whatman-3) showed the presence of 16 different constituent anthocyanins. These are being characterised using standard. chromatographic and spectrophotometric methods. Another concentrated extract using 0.005N HCl in ethanol was deep red in colour (pH 3.2) and applied in jelly crystals and tuti-fruiti. The concentrate (25 mg anthocyanin) was added to 470 gm jelly premix. The colour was found to be stable even after setting. Similarly, the concentrate (74 mg anthocyanin) was added to 470 gm of tuti- fruiti; after processing, and allowed to equilibrate for 48 h, the colour was found to be stable.

FVP-86 SCOPE OF SOLAR DRYING TECHNOLOGY FOR PREPARING GARLIC POWDER

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Garlic cloves with skin were separated from the bulb and the same in 100g lots were dried by methods of sun-drying, oven drying and solar drying using box type cooker. The comparative time taken for solar drying and sun drying at 38-40°C (max. atmosphere temperature) was 8 h and 7 days, respectively, while oven drying took 4 days at 60°C. All these dried samples were grounded, powdered individually (0.5 mm sieve sized) in the electric grinder and subjected to organoleptic evaluation using 9 point Hedonic scale. The solar dried garlic powder was rated as best in aroma, colour, appearance and flavour. All three different dried powdered samples were given to 10 housewives for use in different recipes of daily use along with instructions. Solar dried lot was adjuged as best in their sensory attributes. It was concluded that, solar drying was one of the best method for making dried garlic powder, as this process was less laborious, time saving, product highly acceptable and a cost effect technology. This technology also holds vast scape for propagation as an income generation activity.

FVP-87 MATHEMATICAL MODELLING OF PACKAGING SYSTEM FOR BANANA

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The damage caused to banana fruits after harvesting can be minimised by proper packaging system. A mathematical model was developed to predict the possible damage due to shock, vibration and compression during handling, transportation and storage of banana fruits. The model predicted the economical dimensions of a shipping container of corrugated fibre board used for banana transportation by truck. The results of the analysis indicated that banana could be damaged when dropped from a height more than 0.1 m, if proper cushioning materials were not provided. The maximum acceleration for a package weighing 18 kg and having spring constant of 5000 N/m at a drop height of 2.1 m, was found as 34.2 g. The banana could have vibration damage when the input acceleration of truck exceeds 0.4g. The banana could have compression damage when the load on package exceeds 54 kg. The packaging of banana was found economical only when the packaging material cost was less than Rs 9 per m^2 and the banana procurement cost was more than Rs 3 per kg^2.

FVP-88 PROXIMATE COMPOSITION OF A FEW SELECTED VARIETIES OF POTATO

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Proximate composition of potatoes varied significantly between the varieties. Variety *K. lalima* contained the highest dry matter (25.4 percent) and maximum protein content (1.91 percent). The maximum carbohydrate content of 27.71 percent was observed in variety *K.Jyoti*. The average weight of tubers was 53.87 g. However, the highest tuber weight of 85.43 g was recorded in *K. sadsah* and the lowest of 44.09 g in *K. jyoti*.

FVP-89 CANDIED APPLES - A NEW PERSPEPCTIVE

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After washing, trimming, sorting and scoring, low grade apples were candied by standardised methods. The prepared candy was stored in different packaging materials under different storage conditions. The product was analysed fresh and after every 45 days of storage upto a period of 180 days for quality and nutritional changes. The mean values of TSS, acidity, TSS:acidity ratio, pH, reducing-, non-reducing and total-sugars in fresh candy were 73.50°Brix, 1.40 percent (as malic

acid), 52.50, 5.81, 69.03 percent, 3.61 percent and 72.70 percent and candy after 180 days storage 76.25°Brix were 1.32 percent (as malic acid) 57.80, 6.3, 76.70 percent, 4.23 percent and 81.20 percent, respectively. The product was also evaluated microbiologically and organoleptically for colour, flavour, texture and absence of defects.

FVP-90 **PRODUCT QUALITY OF STORED OSMOTICALLY DEHYDRATED BANANA AND JACK FRUITS**

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Slices of *Rasthale* variety of banana were sulphited for 10 min. in 0.25 percent potassium metabisulphite solution and subjected to osmosis using 70°Brix sugar syrup at 50°C for 3 and 6 h., followed by drying in a cabinet drier. One lot of dried slices was packed in 150 gauge polyethylene bag and the other lot was packed in the same type of polyethylene bag and placed in a metal container. Both the packages were stored at ambinet conditions. In case of jack fruit, sulphuring was carried out, instead of sulphiting. During osmosis, there was a reduction in moisture and ascorbic acid content, while the other chemical constituents showed an increase. The catalase and peroxidase reactions were positive. The weight loss in osmotically dehydrated banana and jack fruits was found to be 45 and 34 percent, respectively. The losses in chemical constituents like ascorbic acid, carotenoids and sugars were more in fruits stored in polyethylene bags as against those packed in polyethylene bags and kept in metal container. The osmotically dehydrated fruit slices had higher scores of acceptable sensory attributes.

GST-22 **SENSORY ATTRIBUTES OF *IDLI* AND *DHOKLA* STEAM COOKED IN JACKFRUIT (*ARTOCARPUS INTEGRIFOLIA*) LEAF CUPS**

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India has a rich heritage of cuisine, among which fermented foods like *idli* and *dhokla* are popular in Southern and Western India, respectively In coastal regions of South India, *idli* is cooked in fresh leaf cups, particularly when they have to be stored for few days and are relished more than those cooked in conventional moulds. The effect of using jack fruit leaf cups for steaming *idli* and *dhokla* on the sensory attributes was studied. The results indicated that, *idli* and *dhokla* cooked in leaf cups were highly acceptable, with the scores being significantly higher for the products cooked in leaf cups than those in moulds. The texture of both the products cooked in leaf cups were porous and spongy. Ink impression revealed uniform distribution of air pockets than in the mould cooked products. The scores for colour, flavour, sourness and overall quality were significantly higher for

leaf cup products. Apart from these attributes, leaf cup products stored well for 5 days at room temperature without any changes in colour, flavour and texture.

GST-23 EFFECT OF PRETREATMENT ON PIGEON PEA MILLING

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To satisfy the need of a suitable low cost rural level pulse process technology with minimum milling losses, pigeon pea was selected as test material and was pretreated in three different lots by soaking in 0.6 percent sodium bicarbonate solution for 30, 40 and 50 min., respectively and then sun-dried to a level of 9-13 percent moisture content (d.b.). It was evident from milling results that, the soaking time of 40 min in 6.0 percent sodium bicarbonate solution with 10-12 percent moisture content (d.b.) range was optimum for getting highest *dhal* recovery (56.33 percent), husk removal (7.66 percent) and milling efficiency (74.10 percent). These results indicated that, chemical pre-milling treatment helps in reducing the soaking time and drying time involved in traditional processing and also yielded higher percentage of *dhal* and husk.

GST-24 INTERACTION BETWEEN PHYSICAL AND MILLING CHARACTERISTICS OF PADDY VARIETIES

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Milling characteristics of 18 common varieties of paddy, grown in Northern India, were studied in terms of percentage of unhulled paddy, husk content, brown rice yield and milling yield in relation to degree of polish. The physical characteristics of these varieties were also determined and correlated with milling parameters through mathematical modelling of experimental data using SPSS software package. The linear, first, second and third order polynomials were fitted and their relative performance for prediction of experimental results were analysed on the basis of correlation coefficient (r), standard error of estimate and magnitude of error corresponding to 88 percent data point. The curvature test for each model was carried out and in case of positive curvature, next higher order model was fitted and compared with lower order model. Sensitivity of each selected model was carried out to analyse the sensitivity of dependent parameter to independent parameter. Out of 18 varieties, UPR-239 gave maximum milling yield, whereas IET-8580 had the lowest yield. The broken rice yield could be mathematically correlated with thickness and width of paddy. The whiteness and milling yield exhibited a linear relationship with degree of polish.

GST-25 BULK DENSITY AND BREAKAGE OF PEAS DURING SPROUTED BED DRYING OF PEAS

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The effect of temperature, pretreatment, sample size and tempering time were studied on bulk density and breakage of peas in a sprouted bed drying. The temperature range was 60-100°C and tempering time range was 0 to 60 min. Five pretreatments, viz., pricking once, pricking twice, hot water blanching, low chemical blanching and high chemical blanching were used. The sample size ranged from 400 to 600 g. It was observed that, the process variables did not affect the bulk density. However, moisture content affected it significantly and linearly. An empirical equation was developed. The higher temperature and chemical pretreatments increased the breakage, while the same was reduced during double pricking and higher load density.

MBT-21 INDIGENOUS PROCESSING OF WHEAT: SCOPE FOR VARIED UTILISATION AND PROPAGATION

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Although wheat is a rich source of protein, carbohydrate, vitamins and minerals, yet presence of antinutritional factors adversely affect the digestibility of many nutrients, while these get lowered during processing. Wheat products fetch a higher remunerative price compared to other forms in which it is readily available. Accordingly, nutritionally rich and commercially viable products would be a step in the right direction. One popular traditional product, *anguri atta* prepared by a few Punjabi families is a fast fading technique, but also holds high viability of utilisation and propagation. This atta was prepared by overnight soaking of wheat, followed by sprouting at 32-35°C for 96 h, followed by sun-drying of sprouts and finally grinding. This processing improves digestibility of proteins and starch and enhances the availability of minerals and has organolpetic acceptability. A popular sweet preparation, in milk, called *dooda* is like granular brown *barfi*/milk cake. This flour also holds scope of incorporation in weaning and supplementary mixtures and many other products of daily use.

OFT-18 PEANUT PROCESSING USING SOLAR COOKER

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Peanut considered to be a poor man's meat is a rich potential source of protein. Box type solar cooker was selected for drying two samples of peanuts. One sample of 100 g was kept directly in the container provided in the solar cooker, while the second sample of 100 g was first soaked overnight in 300 ml of water containing 3 g salt strained in the morning before drying. Both the samples were kept in two separate containers in solar cooker, simultaneously at 40°C (max. atmospheric temperature) for 5 h. Acceptability trials on a 9 point Hedonic scale showed both the samples of peanut had a score of 8 to 9. However, the soaked salted and dried samples was preferred.

MIS-4 FOOD PROCESSING MARKET MANAGEMENT-BASIC ISSUES

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The study was conducted on randomly selected 50 retail shop- keepers of Pusa and nearby markets engaged in sale of various food items; 50 farmers and 50 agricultural labourers selected randomly from Mahmada Village located close to Pusa market; and 50 agricultural scientists of Rajendra Agricultural University selected randomly from among those living on Pusa Campus. The results of the investigation indicated varieties in the dietary pattern of "Service" families and "Non-service" or "farm dependent" families. However, there was only little difference in nutrient uptake pattern between farmers and agricultural labourers. The processed food products were purchased mainly by agricultural scientists (76 percent), followed by the "service" families among the farmers (21 percent). "Non-service" families procured only a few processed food items (3 percent) and that too under medical advice mainly. Poor purchasing power of the "Non- service" families, lack of awareness about different processed food products, doubt about the quality of the food products and lack of proper education of the masses on products and their food-value were some of the important reasons for low consumer response to the processed food products. The results of the investigation raised a few basic issues involved in the processed food market management and which needed consideration.

MIS-5

PACKAGE APPROACH FOR TRANSFER OF FOODS AND NUTRITION MESSAGES: A MANAGEMENT PERSPECTIVE

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A large segment of population does not have adequate/correct nutritional knowledge with respect to food intake, food processing, post-harvest technology, food conservation etc. Extension and welfare agencies do undertake the job of correcting such imbalances through programmes of nutrition education. In order to make a dent in combating such issues and providing expert information on various aspects, it is essential that recommendations are compiled and made available to the functionaries undertaking the job. Accordingly, a package approach enlisting the crucial messages and recommendations for transfer of technology is proposed. It is suggested that, the package be finalised in annual meeting/workshop of experts and field staff at University levels, followed by meeting/workshop at district level. A similar package approach is followed in agriculture. College of Home Science at Haryana Agricultural University has taken a lead in this direction in the field of home science. The first workshop was arranged and draft package discussed with staff of ICDS, health department and home science extension staff of the University.

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